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RF/ER 95 0011

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**Final Trenches and Mound Site
Characterization
Health & Safety Plan
Operable Unit No 2**



February 1995

FINAL

**TRENCHES AND MOUND SITE
CHARACTERIZATION HEALTH AND
SAFETY PLAN
OPERABLE UNIT NO 2**

**U S DEPARTMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL
TECHNOLOGY SITE
GOLDEN, COLORADO**

**ENVIRONMENTAL RESTORATION
PROGRAM**

February 1995

**INFORMATION
ONLY**

FINAL

**TRENCHES AND MOUND SITE
CHARACTERIZATION HEALTH AND
SAFETY PLAN
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**U.S. DEPARTMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL
TECHNOLOGY SITE
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**ENVIRONMENTAL RESTORATION
PROGRAM**

February 1995

REVISION 0

INFC

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Document Modification Request

This is a
CONTROLLED DOCUMENT (5)

8344 ROCKY FLATS PLANT

ENVIRONMENTAL MANAGEMENT DEPARTMENT

This is a ~~RED COPY~~ *ERM-0174*

Originator

Print or Type all information (except signatures) Process procedures in accordance with 1-A01-PROC DEV-400 Procedure Process.

1 Name/Phone/Page/Location Robin Kay Volk X8645 D6145 Bldg 080 #621			2 Date 7/31/95		
3 Existing Document Number and Revision RF/FR-95-001b			4 Document Type <input type="checkbox"/> Procedure <input checked="" type="checkbox"/> Plan <input type="checkbox"/> Other		
5 Document Title Rocky Flats Environmental Technology Site OU-2 Trenches and Mound Site Characterization					
6 Item	7 Page	8 Step	9 Proposed Modification		
1	V1		Insert revised list of appendixes		
2	H		Insert Addendum #1 Resampling subsurface soils and soil gas as Appendix H to the existing Rocky Flats Environmental Technology Site OU-2 Trenches and Mound Site Characterization Site Health and Safety Plan		
10 Item					
10a Justification (reason for modification, EJO's, TP's, etc.)					
1 Additional sampling of IHSS 109 "Trench T-2" is necessary to support the accelerated remediation activities. The existing Health and Safety Plan must be modified to incorporate new information regarding exposure limits of known contaminants in the area to be sampled. Thus necessitating the revising the list of appendixes and adding Appendix H to the existing Health and Safety Plan.					

Originator's Supervisor

Michael J. McHugh

11 <input checked="" type="checkbox"/> Process <input type="checkbox"/> Do not Process (state reason in Block 10a) <i>M. McHugh</i> 7/31/95					
12 <input checked="" type="checkbox"/> Process (Complete Blocks 13-22) <input type="checkbox"/> Do not Process (state reason in Block 10a) <i>Rob Kay Volk R.K. Volk</i> 7/31/95					
13 New Document (Rev No. if new or changed) Rev. 1					
Complete either Section 14a, or 14b as applicable For procedures, attach completed Procedure Modification Worksheet from 1-A01-PROC DEV-400					
14a. Type of Complete Modification		14b Changes (check all that apply)		Additional Attributes:	
<input type="checkbox"/> New <input checked="" type="checkbox"/> Revision		<input type="checkbox"/> Intent Change <input checked="" type="checkbox"/> Nonintent Change		<input checked="" type="checkbox"/> Temporary	
<input type="checkbox"/> One-Time-Use <input type="checkbox"/> Cancellation		<input type="checkbox"/> Editorial Correction <input checked="" type="checkbox"/> Regular		<input type="checkbox"/> One-Time-Use	
		<input type="checkbox"/> Internal Approval Requested (14-day limit for obtaining final approval)		<input type="checkbox"/> Limited Distribution	
15 ERM Change Control Board Required: <input type="checkbox"/> Yes <input type="checkbox"/> No (Applicable only to new procedures, revisions, and intent changes.)					
List the reviewing disciplines in Block 16. After concurrence has been obtained (in accordance with 1-A01-PROC DEV-400) enter the name of the reviewer followed by /s/ in block 17. If the reviewer indicates No comments, the review signature constitutes concurrence. Enter the date concurrence is obtained in Block 18.					
16 Organization	17 Reviewer/Concurrence	18 Date	16a Organization	17a Reviewer/Concurrence	18a Date
RA	<i>M.D. Schreckengast</i>	7/31/95			
Health & Safety	<i>R.K. Volk</i>	7-31-95			
RMBS	<i>Sgt. [Signature]</i>	7/31/95			
RA					
19 Assigned SMC/Phone/Page/Location <i>M.D. Schreckengast</i> 6079 D3059 Bldg 4 3112 984217 8/1/95					
20 Cost Center 21 Change Number 22 Requested Completion Date					
23 Precursor/Screen/USCD Number 24 Independent Safety Review Meeting and Date					
25 After obtaining ALL required signatures Responsible Manager's Approval (print/sign/date) (Not required for New procedures or Revisions)					
<i>Rob Kay Volk</i> <i>R.K. Volk</i> 7/31/95					
27 Effective Date 7/31/95					
28 Expiration Date (if applicable) 12/31/95					



INFORMATION ONLY

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	1 of viii
	Effective Date	03-03-95
	Organization	Environmental Restoration Program Div
		REVISION 0

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
1 0 ADMINISTRATIVE INFORMATION	1
2 0 INTRODUCTION	3
3 0 PROJECT PERSONNEL	4
4 0 SITE INFORMATION	15
4 1 BACKGROUND	15
4 2 TRENCHES AND MOUND SITE	15
4 2 1 Trench T-1 (IHSS 108)	16
4 2 2 Trench T-2 (IHSS 109)	17
4 2 3 Trench T-4 (IHSS 111 1)	17
4 2 4 Trench T-5 (IHSS 111 2)	18
4 2 5 Trench T-6 (IHSS 111 3)	18
4 2 6 Trench T-7 (IHSS 111 4)	19
4 2 7 Trench T-8 (IHSS 111 5)	19
4 2 8 Trench T-9 (IHSS 111 6)	19
4 2 9 Trench T-10 (IHSS 111 7)	20
4 2 10 Trench T-11 (IHSS 111 8)	20
4 2 11 Trench T-12	20
4 2 12 Trench T-13	21
4 2 13 Mound Site (IHSS 113)	21
5 0 SCOPE OF WORK	25
5 1 TASK 1 - MOBILIZATION	25
5 2 TASK 2 - NON-INTRUSIVE GEOPHYSICS	25

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	11 of viii
	Effective Date	
	Organization	Environmental Restoration Program Div

5 3	TASK 3 - SOIL GAS SURVEY	26
5 4	TASK 4 - SUBSURFACE SAMPLING	26
5 5	TASK 5 - DECONTAMINATION	26
6 0	HAZARD ASSESSMENT	28
6 1	CHEMICAL HAZARDS	28
6 1 1	Volatile Organic Compounds (VOCs)	29
6 1 2	Polycyclic Aromatic Hydrocarbons	30
6 1 3	Polychlorinated Biphenyls (PCBs)	30
6 1 4	Metals	31
6 2	RADIOLOGICAL HAZARDS	34
6 3	PHYSICAL HAZARDS	36
6 3 1	Drilling	36
6 3 2	Noise Exposure	36
6 3 3	Heat and Cold Stress	37
6 3 4	Personal Protective Equipment (PPE)	37
6 3 5	Overhead Hazards	37
6 3 6	Traffic Hazards	37
6 4	BIOLOGICAL HAZARDS	38
6 5	TASK BY TASK HAZARD ANALYSIS	38
7 0	GENERAL HEALTH AND SAFETY REQUIREMENTS	47
7 1	MEDICAL SURVEILLANCE	47

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	iii of viii
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

7 2	SAFETY TRAINING	47
7 2 1	40-hour Basic Training	48
7 2 2	Three-day On-site Supervision	48
7 2 3	Radiation Safety Course	48
7 2 4	On-site Supervisor	48
7 2 5	Site Safety and Health Officer (SSHO)	48
7 2 6	Health and Safety Technician (HST)	49
7 3	SITE SPECIFIC SAFETY BRIEFING	49
7 4	ACCIDENT/INCIDENT REPORTING	50
7 4 1	W-C Procedures	50
7 4 2	Rocky Flats Procedures	51
7 5	VISITOR CLEARANCES	52
7 6	HEALTH AND SAFETY LOGBOOK	52
7 7	SAFETY COMPLETION REPORT	53
8 0	SITE-SPECIFIC HEALTH AND SAFETY REQUIREMENTS	54
8 1	WORK ZONES	54
8 2	PERSONAL PROTECTIVE EQUIPMENT	55
8 3	MONITORING REQUIREMENTS	55
8 3 1	Monitoring Calibration and Documentation	56
8 4	ACTION LEVELS	57

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	iv of viii
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

8 5	DECONTAMINATION	57
8 5 1	Personnel Decontamination	57
8 5 2	Equipment Decontamination	59
8 6	WORK PRACTICES	59
8 6 1	Drilling Safety	59
8 6 2	Confined Space Entry	60
8 6 3	Spill Containment Plan	60
8 6 4	Dust Control Measures	60
8 6 5	Buddy System	60
8 6 6	Communications	61
8 6 7	Prohibited Activities	61
8 6 8	Illumination	61
8 6 9	Sanitation	62
9 0	EMERGENCY RESPONSE	67
9 1	EMERGENCY SERVICES	67
9 1 1	Emergency Phone Numbers	67
9 1 2	Rocky Flats Occupational Health Medical Facility (Building 122)	67
9 1 3	Avista Hospital	68
9 2	EMERGENCY RESPONSE PROCEDURES	68
9 2 1	Emergency Medical Procedures	69
9 2 2	First Aid - Chemical Injury	70

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	v of viii
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

9 2 3	First Aid - Physical Injury	71
9 2 4	Injury Due to Heat	73
9 2 5	Fire/Explosion	74
9 2 6	Natural Disasters	74
9 3	EMERGENCY EQUIPMENT	75
10 0	REFERENCES	80

LIST OF TABLES

TABLE 3-1	HEALTH AND SAFETY RELATED RESPONSIBILITIES AND AUTHORITIES
TABLE 3-2	PROJECT PHONE LIST
TABLE 6-1	PHYSIOCHEMICAL CHARACTERISTICS OF CHEMICALS OF CONCERN
TABLE 6-2	TASK BY TASK HAZARD ANALYSIS
TABLE 8-1	PERSONAL PROTECTIVE EQUIPMENT LEVELS
TABLE 8-2	MONITORING ACTION LEVELS
TABLE 8-3	TASK AND LOCATION SPECIFIC MONITORING REQUIREMENTS

LIST OF FIGURES

FIGURE 3-1	HEALTH AND SAFETY RELATED PROJECT ORGANIZATION
FIGURE 4-1	GENERAL LOCATION OF ROCKY FLATS
FIGURE 4-2	LOCATION AND IDENTIFICATION OF IHSSs
FIGURE 9-1	EMERGENCY PHONE NUMBERS AND HOSPITAL ROUTES
FIGURE 9-2	ROUTE TO ROCKY FLATS MEDICAL FACILITY
FIGURE 9-3	ROUTE TO AVISTA HOSPITAL

Rocky Flats Environmental
Technology Site
OU-2 Trenches and Mound Site
Characterization Site Health and
Safety Plan

Document No
Section No
Page
Effective Date
Organization Environmental Restoration Program Div

RF/ER-95-0011

vi of viii

LIST OF APPENDIXES

APPENDIX A	COMPLIANCE AGREEMENT
APPENDIX B	MATERIAL SAFETY DATA SHEETS
APPENDIX C	HEAT STRESS/COLD STRESS
APPENDIX D	TICKS AND TICKBORNE DISEASES
APPENDIX E	SAFETY COMPLETION REPORT
APPENDIX F	CALIBRATION RECORDS
APPENDIX G	PERSONAL INTEGRATED SAMPLING
APPENDIX H	ADDENDUM #1 RESAMPLING SUBSURFACE SOILS AND SOIL GAS

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	vii of viii
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

LIST OF ACRONYMS

1,1,1-TCA	1,1,1-trichloroethane
1,2-DCA	1,2-dichloroethane
4,4'-DDT	4,4'-dichlorodiphenyltrichloroethane
ACGIH	American Conference of Governmental Industrial Hygienists
Am-241	americium-241
bgs	below ground surface
BSLs	background screening levels
CCl ₄	carbon tetrachloride
CHSO	Corporate Health and Safety Officer
CNS	central nervous system
COC	chemicals of concern
CPR	cardiopulmonary resuscitation
CRZ	Contamination Reduction Zone
Cs-137	cesium-137
dBA	decibels on the A-weighted scale
DOE	Department of Energy
EM	electromagnetics
EMRGs	Environmental Management Radiological Guidelines
ER	Environmental Restoration
FID	flame ionization detector
GPR	ground penetrating radar
H-3	tritium
HASP	Health and Safety Plan
HRR	Historical Release Report
HSO	Health and Safety Officer
HSP	Health and Safety Practices Manual
HSS	Health and Safety Specialist
HSST	Health and Safety Specialist in-training
HST	Health and Safety Technician

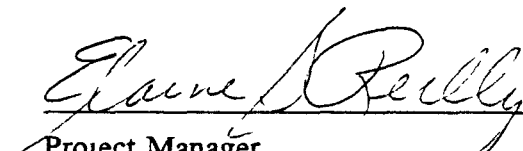
IDLH	Immediately dangerous to life or health
IHSSs	Individual Hazardous Substance Sites
MSDS	Material Safety Data Sheets
OU-2	Operable Unit 2
OVD	organic vapor detector
PA	Protected Area
PAH	Polyaromatic hydrocarbons
PCBs	Polychlorinated Biphenyls
PCE	tetrachloroethene
PEL	Permissible Exposure Limits
PEL-TWA	Permissible Exposure Limit -Time Weighted Average
PID	photoionization detector
PM	Project Manager
PPE	Personal Protective Equipment
Pu-239/240	plutonium-239/240
Ra-226	radium-226
RWP	Radiological Work Permits
SOPs	Standard Operating Procedures
Sr-89,90	strontium-89, 90
SSHO	Site Safety and Health Officer
SVOCs	semi-volatile organic compounds
SZ	Support Zone
TCE	trichloroethene
TLV	Threshold Limit Values
TLV-TWA	Threshold Limit Value - Time Weighted Average
U-233/234	uranium-233/234
VOCs	volatile organic compounds
W-C	Woodward-Clyde
WCGI	Woodward-Clyde Group Incorporated

Rocky Flats Environmental Technology Site	Document No Section No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Page	1 of 80
Characterization Site Health and Safety Plan	Effective Date Organization	Environmental Restoration Program Div

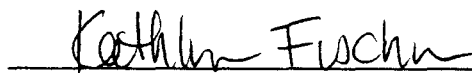
1.0 ADMINISTRATIVE INFORMATION

Project Name	Operable Unit 2 (OU-2) Trenches and Mound Site Characterization
Project Number	4040A
Business Unit	Denver
Date of Issue	January 1995
Effective Dates	January 1995 - December 1995

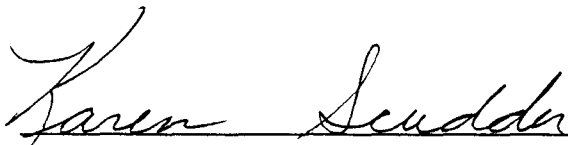
Approvals


 Project Manager
 Elaine Reilly

2-22-95
 Date


 Denver Health and Safety Officer
 Kathleen Fischer

2-22-95
 Date


 Corporate Health and Safety Officer
 Karen Scudder, CIH

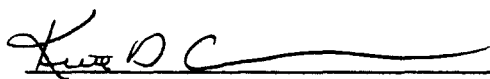
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Rocky Flats Environmental
Technology Site
OU-2 Trenches and Mound Site
Characterization Site Health and
Safety Plan

Document No
Section No
Page
Effective Date
Organization Environmental Restoration Program Div

RF/ER-95-0011

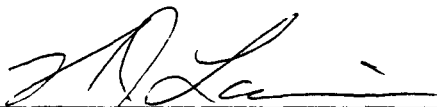
2 of 80



EG&G ER Health and Safety Officer
Keith Anderson

2/27/95

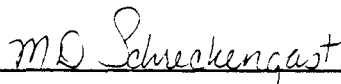
Date



EG&G Project Manager
Pete Laurin

2/27/95

Date



EG&G Health and Safety Liaison Officer
Peggy Schreckengast

2 27-95

Date

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	3 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

2.0 INTRODUCTION

This Health and Safety Plan (HASP) establishes guidelines and requirements for the safety of field personnel during the conduct of the field activities associated with the OU-2 Trenches and Mound Site Characterization

The specific activities addressed by this plan are defined in Section 5.0. Prior to initiating field activities, all on-site Woodward-Clyde (W-C) personnel shall be fully briefed on the contents of this plan, and shall be allowed to review a written copy of the plan. All W-C employees involved in this project are required to abide by the provisions of this plan and to sign the attached Compliance Agreement (Appendix A). In addition to this site-specific plan, personnel shall comply with the Woodward-Clyde health and safety program as outlined in the Health and Safety Manual, June 1993 and the Rocky Flats Health and Safety Practices Manual (HSP).

The health and safety guidelines and requirements presented are based on a review of available information and an evaluation of potential hazards. This plan outlines the health and safety procedures and equipment required for activities at this site to minimize the potential for exposures of field personnel. This plan may be modified by the Project Manager (PM), the business unit Health and Safety Officer (HSO) and the Corporate Health and Safety Officer (CHSO) in response to additional information obtained regarding the potential hazards to field investigative personnel with the approval of the operating contractor Project Manager, the operating contractor Environmental Restoration (ER) Health and Safety Officer, and the operating contractor Health and Safety Liaison Officer.

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	4 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

3.0 PROJECT PERSONNEL

The responsibilities and authorities of each individual, relating to health and safety issues, are presented in Table 3-1. A project phone list is presented in Table 3-2. A project organization chart is included as Figure 3-1.

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	5 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

TABLE 3-1
HEALTH AND SAFETY RELATED RESPONSIBILITIES AND AUTHORITIES

PERSON	RESPONSIBILITIES	AUTHORITIES
W-C Project Manager Elaine Reilly	<ul style="list-style-type: none"> Assure that the project is performed in a manner consistent with the W-C Health and Safety Program Assure that the HASP is prepared, approved, and properly implemented Assure that adequate funds are allocated to fully implement project health and safety Coordinate with the HSO on health and safety matters 	<ul style="list-style-type: none"> Assign an HSO approved SSHO to the project and, if necessary, assign a suitably qualified replacement Suspend field activities if health and safety of personnel are endangered, pending further consideration by the HSO and/or CHSO Suspend a W-C individual from field activities for infractions of the HASP, pending an evaluation by the HSO, CHSO and/or Woodward-Clyde Group Incorporated (WCGI) and Safety Manager

Rocky Flats Environmental
Technology Site
OU-2 Trenches and Mound Site
Characterization Site Health and
Safety Plan

Document No RF/ER-95-0011
Section No
Page 6 of 80
Effective Date
Organization Environmental Restoration Program Div

TABLE 3-1
HEALTH AND SAFETY RELATED RESPONSIBILITIES AND AUTHORITIES
(Continued)

PERSON	RESPONSIBILITIES	AUTHORITIES
WCGI Health and Safety Manager Phil Jones	<ul style="list-style-type: none">• Administer the Health and Safety Program• Track health and safety regulations that affect W-C• Maintain W-C records pertaining to medical surveillance, training, fit testing, chemical exposure, and incidents• Update the W-C Health and Safety Manual• Manage the W-C employee medical surveillance program• Audit key aspects of the W-C Health and Safety Program• Supervise CHSOs	<ul style="list-style-type: none">• Implement improvements to the W-C Health and Safety Program• Approve the health and safety qualifications of employees• Establish employee training and medical surveillance procedures• Approve or disapprove Health and Safety Plans• Suspend work on any project that jeopardizes the health and safety of personnel

TABLE 3-1
HEALTH AND SAFETY RELATED RESPONSIBILITIES AND AUTHORITIES
(Continued)

PERSON	RESPONSIBILITIES	AUTHORITIES
W-C Corporate Health and Safety Officer (CHSO) Karen Scudder	<ul style="list-style-type: none">• Direct the implementation and coordination of the Health and Safety Program of the Operating Group (or responsibility area) and provide recommendations for improvement of the program• Determine the need for project Health and Safety Plans• Maintain a high level of understanding regarding health and safety regulations affecting W-C• Review and approve Health and Safety Plans• Monitor implementation of Health and Safety Plans• Investigate reports of incidents or accidents and report to WCGI Health and Safety Manager• Provide W-C employee health and safety training in the Operating Group, particularly refresher training	<ul style="list-style-type: none">• Approve or disapprove Health and Safety Plans• Direct Operating Unit HSO to prepare project Health and Safety Plans• Access and review W-C project files• Direct changes in personnel work practices to improve health and safety of employees• Remove individuals from project, if their conduct jeopardizes their health and safety or that of coworkers• Suspend work on any project that jeopardizes the health and safety of personnel involved

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	8 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

TABLE 3-1
HEALTH AND SAFETY RELATED RESPONSIBILITIES AND AUTHORITIES
(Continued)

PERSON	RESPONSIBILITIES	AUTHORITIES
	<ul style="list-style-type: none"> • Determine whether an accidental exposure or injury merits a change in the affected individual's work assignments and whether changes in work practices are required • Coordinate Operating Units with regard to health and safety equipment needs • Supervise HSOs through the matrix management system in cooperation with the Operating Unit Manager 	

Rocky Flats Environmental
Technology Site
OU-2 Trenches and Mound Site
Characterization Site Health and
Safety Plan

Document No
Section No
Page
Effective Date
Organization Environmental Restoration Program Div

RF/ER-95-0011

9 of 80

TABLE 3-1
HEALTH AND SAFETY RELATED RESPONSIBILITIES AND AUTHORITIES
(Continued)

PERSON	RESPONSIBILITIES	AUTHORITIES
W-C Operating Unit Health and Safety Officer (HSO) Kathleen Fischer	<ul style="list-style-type: none">• Administer the Health and Safety Program within the Operating Unit• Maintain a working understanding of key government health and safety regulations and W-C health and safety policies• Interface with project managers concerning health and safety• Report to CHSO on health and safety matters• Develop or review, approve or disapprove project Health and Safety Plans prior to submittal to the CHSO for review• Conduct W-C staff training and orientation on health and safety-related activities• Appoint or approve SSHOs• Monitor compliance with Health and Safety Plans and conduct site audits• Assist project managers in obtaining required health and safety equipment• Approve personnel to work on hazardous waste management projects with regard to medical examinations and health and safety training• Answer employee questions and concerns regarding health and safety	<ul style="list-style-type: none">• Suspend work or otherwise limit exposures to personnel, if health and safety risks are unacceptable• Direct personnel to change work practices, if existing practices are deemed to be hazardous to health and safety of personnel• Remove personnel from projects, if their actions or conditions endanger their health and safety, or the health and safety of co-workers

Rocky Flats Environmental
Technology Site
OU-2 Trenches and Mound Site
Characterization Site Health and
Safety Plan

Document No
Section No
Page
Effective Date
Organization Environmental Restoration Program Div

RF/ER-95-0011

10 of 80

TABLE 3-1
HEALTH AND SAFETY RELATED RESPONSIBILITIES AND AUTHORITIES
(Continued)

PERSON	RESPONSIBILITIES	AUTHORITIES
W-C Site Safety and Health Officer (SSHO) Bob Lahn	<ul style="list-style-type: none">• Direct health and safety activities on site• Immediately report all safety-related incidents or accidents to the HSO and the Project Manager• Assist Project Managers in all aspects of implementing Health and Safety Plans• Maintain health and safety equipment on site• Implement emergency procedures, as required• Review certifications/medical surveillance status of all site personnel prior to site access• Maintain health and safety records for W-C and subcontractor personnel on site (including medical examinations, training, compliance agreements, and incident/accident reports)	<ul style="list-style-type: none">• Temporarily suspend field activities if health and safety of personnel are endangered, pending further consideration by the HSO and/or CHSO• Temporarily suspend a W-C individual from field activities for infractions of the Safety and Health Plan, pending an evaluation by the HSO and/or CHSO

Rocky Flats Environmental
Technology Site
OU-2 Trenches and Mound Site
Characterization Site Health and
Safety Plan

Document No
Section No
Page
Effective Date
Organization Environmental Restoration Program Div

RF/ER-95-0011

11 of 80

TABLE 3-1
HEALTH AND SAFETY RELATED RESPONSIBILITIES AND AUTHORITIES
(Continued)

PERSON	RESPONSIBILITIES	AUTHORITIES
W-C Health and Safety Specialist (HSS) Bob Lahn	<ul style="list-style-type: none">• Conduct surveys and document the results, as required by the Environmental Management Radiological Guidelines (EMRGs), the HSP, and the Rocky Flats Site-Wide Standard Operating Procedures (SOPs)• Supervise Health and Safety Specialist in-Training (HSST) during field activities• Countersign all reports/forms completed by the HSST• Forward completed survey reports forms to the SSHO• Notify the SSHO of hazard levels requiring access controls not already established or levels exceeding an established action level• Control access and advise all personnel when radiological precautions are required• Complete performance and operational checks required for radiation instruments and make entries in the Instrumentation Field Log Book	<ul style="list-style-type: none">• Temporarily suspend field activities, if health and safety of personnel are endangered, pending further consideration by the HSO and/or CHSO• Temporarily suspend an individual from field activities for infractions of the Health and Safety Plan, pending an evaluation by the HSO and/or CHSO

Rocky Flats Environmental
Technology Site
OU-2 Trenches and Mound Site
Characterization Site Health and
Safety Plan

Document No

RF/ER-95-0011

Section No

Page

12 of 80

Effective Date

Organization Environmental Restoration Program Div

TABLE 3-1
HEALTH AND SAFETY RELATED RESPONSIBILITIES AND AUTHORITIES
(Continued)

PERSON	RESPONSIBILITIES	AUTHORITIES
Health and Safety Technician (HST) As Assigned by the Site Manager and Project Manager in concurrence with the HSO	<ul style="list-style-type: none">• The HSTs shall assist the SSHO in implementing site Health and Safety Plans. An HST will be present (in the immediate vicinity) during all activities involving drilling, trenching, or sampling of wastes or soils. None of these activities shall be permitted in the absence of an HST.• Ensure that each individual within his/her jurisdiction complies with the provisions of the HASP.• Provide on-site air monitoring during field activities.• Audit safety practices used by on-site teams.• Communicate with command post for on-site activities.• Supervise decontamination, monitor workers for heat or cold stress, and distribute health and safety equipment.• Document safety practices.• Initiate appropriate emergency procedures.	<ul style="list-style-type: none">• The health and safety technician shall have the authority to stop work in case of an imminent safety hazard or potentially dangerous situation. After stopping work, the health and safety technician shall immediately consult the SSHO.

Rocky Flats Environmental
Technology Site
OU-2 Trenches and Mound Site
Characterization Site Health and
Safety Plan

Document No
Section No
Page
Effective Date
Organization Environmental Restoration Program Div

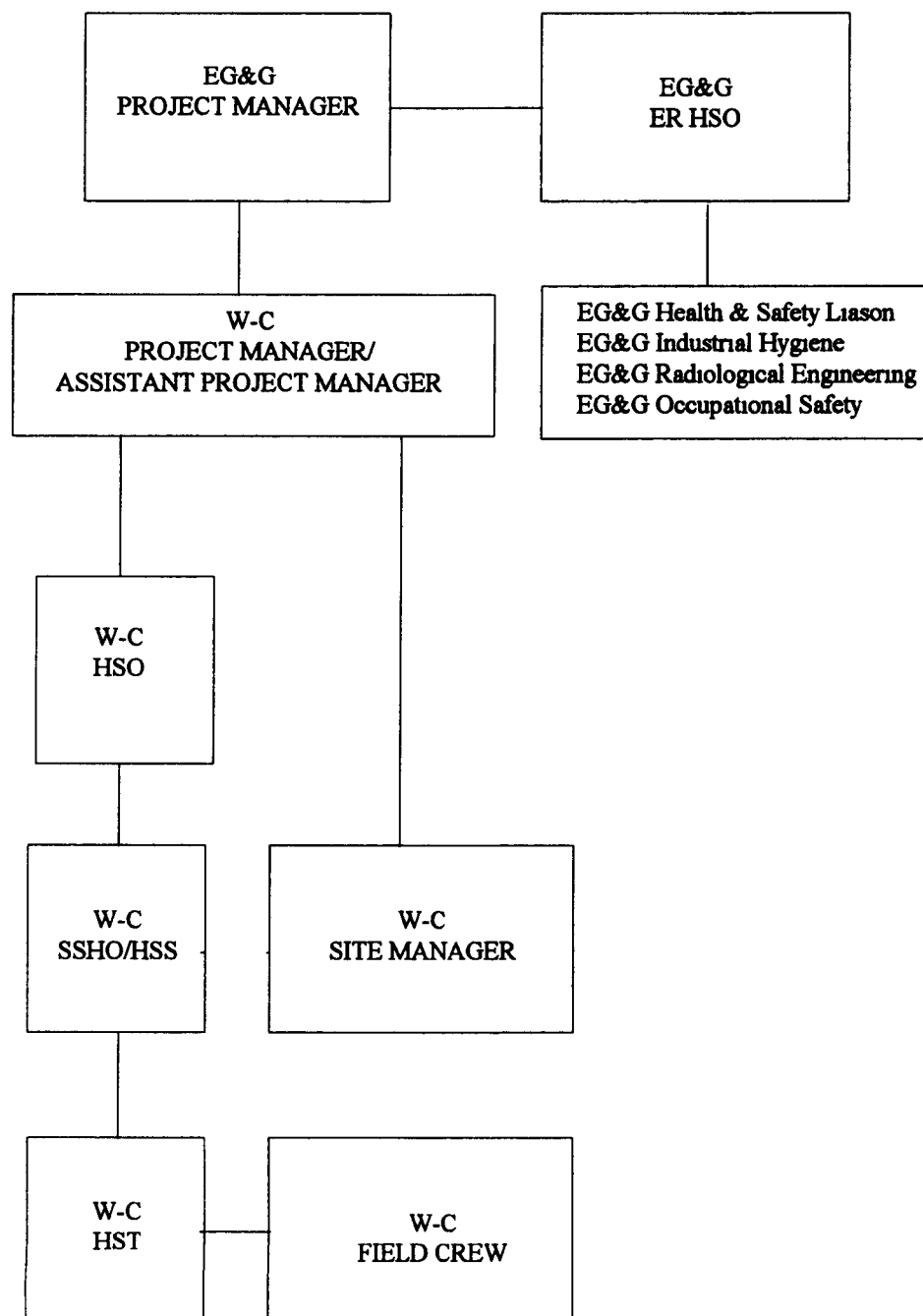
RF/ER-95-0011

13 of 80

TABLE 3-2
PROJECT PHONE LIST

NAME	TITLE	WORK NUMBER	PAGER NUMBER
Pete Laurin	EG&G Project Manager	966-8702	966-4000 #5481
Robin Volk	EG&G Assistant Project Manager	966-8645	966-4000 #6145
Jeff Bray	EG&G Assistant Project Manager	966-8533	966-4000 #6143
Peggy Schreckengast	EG&G Health and Safety Liaison	966-6790	966-4000 #3059
Kerth Anderson	EG&G ER Health and Safety Officer	966-6979	966-4000 #5142
Rick Gentry	EG&G Radiation Engineering Representative	966-8349	966-4000 #3521
FJ Furman	EG&G Occupational Health Director	966-2895	966-4000 #2356
Elaine Reilly	W-C Project Manager	740-3831	
Nan Elzinga	W-C Assistant Project Manager	740-2740	851-3847
Karen Scudder	W-C CHSO	740-3837	760-1814
Kathleen Fischer	W-C HSO	796-4616	
Robert Lahn	W-C SSHO	966-8022	760-7599
Art Gust	W-C Task Manager/Site Manager	966-8022	
Rock Powell	W-C Sample/Data Manager	796-4623	
Pierre Girod	W-C Rig Geologist	740-3993	
To be determined	W-C Rig Geologist	740-2700	
Dave Nicholson	W-C Rig Geologist	740-3827	
Doug Schroer	W-C HST	740-2679	
Bob Hencmann	W-C HST	740-2656	
To be determined	W-C HST	740-2700	

**FIGURE 3-1
HEALTH AND SAFETY RELATED PROJECT ORGANIZATION**



Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	15 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

4.0 SITE INFORMATION

4.1 BACKGROUND

Rocky Flats is located northwest of Denver in central Colorado. The facility consists of approximately 6,550 acres of federally owned land. Major buildings are located within a security area of approximately 400 acres. The security area is surrounded by a buffer zone of approximately 6,150 acres. The entire facility is roughly bounded by State Highway 93 on the west, State Highway 128 on the north, Indiana Street on the east, and State Highway 72 on the south (see Figure 4-1).

Rocky Flats began operations in 1952 and is part of the nationwide nuclear weapons development, production, and research complex currently administered by the Department of Energy (DOE). Primary production activities included fabrication of nuclear weapons components from beryllium, plutonium, stainless steel, and uranium, assembly of components, and chemical recovery and purification of recyclable transuranic radionuclides. The major classes of waste generated includes hazardous waste, radioactive waste, and mixed (radioactive and hazardous) waste.

4.2 TRENCHES AND MOUND SITE

The following sections provide the general location of the trenches and the Mound Site, brief description of the disposal practices at each trench and the Mound Site, data collected from previous investigations to characterize the sites, and a summary of the contaminants that have been detected in or around these Individual Hazardous Substance Sites (IHSSs) (DOE 1993). This information is based upon analytical data from previous field investigations. Specifically, the data is from subsurface soil samples obtained from boreholes drilled along side Trench T-1, T-2, and T-4 through T-13. Analytical data from boreholes drilled next to Trench T-3 reflects similar compounds and concentrations as seen for Trenches T-1, T-2, and T-4 through T-13. However, data recently obtained from drilling into Trench T-3 shows the

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	16 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

levels of contamination to be significantly higher within the trench boundaries. The chemical concentrations are listed in Table 6-1. The highest activities detected for radionuclides are 7.49×10^5 picoCuries per liter (pCi/l) for gross alpha and 8.03×10^5 pCi/l for gross beta. Work activities for this project will include intrusive activities into Trenches T-1, T-2, and T-4 through T-13. T-3 will not be included in this program. Therefore, these higher concentrations of contaminants are used in this HSP to determine appropriate health and safety controls. Figure 4-2 shows the location of Trenches T-1 through T-13 and the Mound Site.

4.2.1 Trench T-1 (IHSS 108)

Trench T-1 (IHSS 108) is located north of the Central Avenue, west of the inner east gate, southeast of the Protected Area (PA) fence, and south of the Mound Site (Figure 1.1-3). One hundred twenty-five drums containing depleted uranium chips, hydraulic oil, and carbon tetrachloride (CCl_4) were disposed of in Trench T-1 from 1954 to 1962. Some of the drums contained metal turnings still bottoms (residue from a distillation process), cemented cyanide waste, and copper alloy.

Data from Trench T-1 does not show elevated levels of VOCs, SVOCs, pesticides, polychlorinated biphenyls (PCBs), or metals. Slightly elevated activities of americium-241 (Am-241) and plutonium-239/240 (Pu-239/240), which decrease with depth, were detected in Trench T-1 or in the surface or near surface soils around Trench T-1. However, drums containing pyroforic uranium are believed to have been disposed of in Trench T-1. Due to hazards associated with drilling through pyroforic uranium, intrusive methods to be used at Trench T-1 will be evaluated based on the results of the electromagnetic geophysical survey (DOE 1993).

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	17 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

4.2.2 Trench T-2 (IHSS 109)

Trench T-2 (IHSS 109) is located approximately 100 feet south of the 903 Pad (Figure 1 1-3). The HRR states that the trench was open and nonradioactive solvents were dumped into Trench T-2 in 1969 and 1970. The solvents that may have been dumped include tetrachloroethene (PCE) and trichloroethene (TCE). In addition to solvent dumping, thinner and small quantities of construction-related chemicals were reportedly disposed of in Trench T-2. The dimensions of Trench T-2 are believed to be approximately 20 feet long, 10 feet wide, and 5 feet deep.

Trench T-2 (IHSS 109) contains PCE, TCE, and other VOCs that may have been transported to the surrounding subsurface soil. Polyaromatic hydrocarbons (PAHs) were detected at depths of 44 feet and greater. PAHs were not detected above the contract required quantitation limit (CRQL) in samples collected at depths less than 44 feet bgs. Arsenic, cadmium, and barium exceeded the background screening levels (BSLs) of the background mean plus two standard deviations in samples collected from within Trench T-2. In general, the activity of Am-241 and Pu-239/240 decreased with depth (DOE 1993).

4.2.3 Trench T-4 (IHSS 111.1)

Trench T-4 (IHSS 111.1) is located east of Trench T-3, south of South Walnut Creek, and north of Central Avenue (Figure 1 1-3). The depth of Trench T-4 is estimated to be between 5 and 10 feet. Sanitary sewage sludge contaminated with uranium and plutonium, flattened drums contaminated with uranium, and uranium-contaminated asphalt planking from the solar ponds were reportedly buried in Trench T-4 from 1954 to 1968.

Elevated concentrations of PCE and TCE are present in Trench T-4. The concentrations decrease with depth. There are PAHs in the 2-to 8-foot sampling interval which is located within Trench T-4. Aroclor-1254 and 4,4'-dichlorodiphenyltrichloroethane (4,4'-DDT) were detected in one sample from Trench T-4. Metal contaminants include arsenic, cadmium,

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	18 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

chromium, copper, mercury, lead, silver, and zinc Radionuclide contaminants include Am-241, Pu-239/240, U-233,-234, U-235, and U-238 The metal and radionuclide contaminants are believed to be limited to the trench and do not appear to have migrated vertically (DOE 1993)

4.2.4 Trench T-5 (IHSS 111.2)

Trench T-5 (IHSS 111 2) is located south of Central Avenue, west of the East Spray Field, north of Trench T-6, and northeast of Trench T-9 (Figure 1 1-3) Sanitary sewage sludge contaminated with uranium and plutonium, and flattened drums contaminated with uranium were reportedly buried from 1954 to 1968

The analytical results show that potential contaminants are limited to VOCs in Trench T-5 Low concentrations of 1,1,1-TCA and 1,2-DCA are present in the subsurface soils at Trench T-5 (DOE 1993)

4.2 5 Trench T-6 (IHSS 111.3)

Trench T-6 (IHSS 111 3) is located south of Trench T-5, west of the East Spray Fields, north of Trench T-7, and east of Trench T-9 (Figure 1 1-3) The trench is estimated to be approximately five to ten feet deep Sanitary sewage sludge contaminated with uranium and plutonium, and flattened drums contaminated with uranium were reportedly buried from 1954 to 1968

The analytical data collected from Trench T-6 showed that low concentrations of total xylenes and low activities of Pu-239/240 may be present in the subsurface soils (DOE 1993)

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	19 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

4.2.6 Trench T-7 (IHSS 111.4)

Trench T-7 (IHSS 111 4) is located south of Trench T-6, west of the East Spray Fields, north of Trench T-8, and east of Trench T-9 (Figure 1 1-3) Sanitary sewage sludge contaminated with uranium and plutonium was reportedly buried between 1954 and 1968

Low levels of 1,2-DCA and total xylenes are present in Trench T-7 soils Elevated levels of Am-241 and Pu-239/240 were observed in Trench T-7 (DOE 1993)

4.2.7 Trench T-8 (IHSS 111.5)

Trench T-8 (IHSS 111 5) is located south of Trench T-7, west of the East Spray Field, north of Woman Creek, and east of Trench T-9 (Figure 1 1-3) Sanitary sewage sludge contaminated with uranium and plutonium, and flattened drums contaminated with uranium were reportedly buried from 1954 to 1967

Low concentrations of 1,2-DCA are present in Trench T-8 Elevated concentrations of lead in the near-surface soils may be indicative of contamination in Trench T-8 Pu-239/240 contamination may be present at low activities within Trench T-8 (DOE 1993)

4.2.8 Trench T-9 (IHSS 111.6)

Trench T-9 (IHSS 111 6) is located southwest of Central Avenue, west of Trench T-7, and north of Woman Creek (Figure 1 1-3) Sanitary sewage sludge contaminated with uranium and plutonium, and flattened drums contaminated with uranium, scrap metal, and junk were reportedly buried from 1954 to 1968

The analytical data for Trench T-9 indicate that 1,2-DCA and total xylenes were detected in the subsurface soils PAHs and Aroclor-1254 were detected in the upper eight feet Infrequent detections of metals exhibiting low concentrations only slightly above the BSLs

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	20 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

were observed in samples from Trench T-9 Low activities of Pu-239/240 contamination appear to be present in Trench T-9 (DOE 1993)

4.2.9 Trench T-10 (IHSS 111.7)

Trench T-10 (IHSS 111 7) is located north of Central Avenue, east of Trench T-11, and south of Trench T-4 (Figure 1 1-3) Trench T-10 was reportedly used for the burial of sanitary sewage sludge contaminated with uranium and plutonium In addition to the sludge, flattened drums contaminated with uranium were reportedly disposed of in Trench T-10 between 1954 and 1968 (DOE 1993)

4.2.10 Trench T-11 (IHSS 111.8)

Trench T-11 (IHSS 111 8) is located north of Central Avenue, west of Trench T-10, and south of Trench T-3 (Figure 1 1-3) Sanitary sewage sludge contaminated with uranium and plutonium, flattened drums contaminated with uranium and plutonium, and plutonium- and uranium-contaminated asphalt planking from the solar ponds were reportedly buried in Trench T-11 from 1954 to 1968

The analytical data collected from Trench T-11 indicate that 1,1,1-TCA was detected in the subsurface soil Samples with elevated VOC results were collected below high groundwater level, therefore the presence of other VOC contaminants may be associated with the contaminated upper hydrostratigraphic unit (UHSU) groundwater in this area Low-level Pu-239/240 contamination may also exist in Trench T-11 (DOE 1993)

4.2.11 Trench T-12

Trench T-12 is located east of the inner east guard station and south of Trench T-13 (Figure 1 1-3) It is now partially covered with asphalt or base material of the east access road The HRR states that this trench is estimated to be about ten feet deep and primarily contains

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	21 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

sewage sludge This sewage sludge is believed to contain uranium and plutonium contamination Flattened drums may also be present in this trench Elevated activities of Am-241 and Pu-239/240 exist in the surface soils or near surface soils around Trench T-12 (DOE 1993)

4.2.12 Trench T-13

Trench T-13 is located approximately 500 feet east northeast of the inner east guard station and south of IHSS 111 8 (Figure 1 1-3) Aerial photographs indicate that it was open between 1966 and 1967 It is now entirely covered by asphalt or base material as part of the northern extension of the east access road, which was built in 1968 The total length of the trench is approximately 250 feet The aerial photos indicate that it was filled with dark grey material, which may be sewage sludge No source boreholes were drilled into Trench T-13, since this trench was not identified until the preparation of the HRR and after the OU-2 field work had been completed However, previous process knowledge suggests that Trench T-13 contained the same types of waste as the other nearby trenches (DOE 1993)

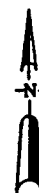
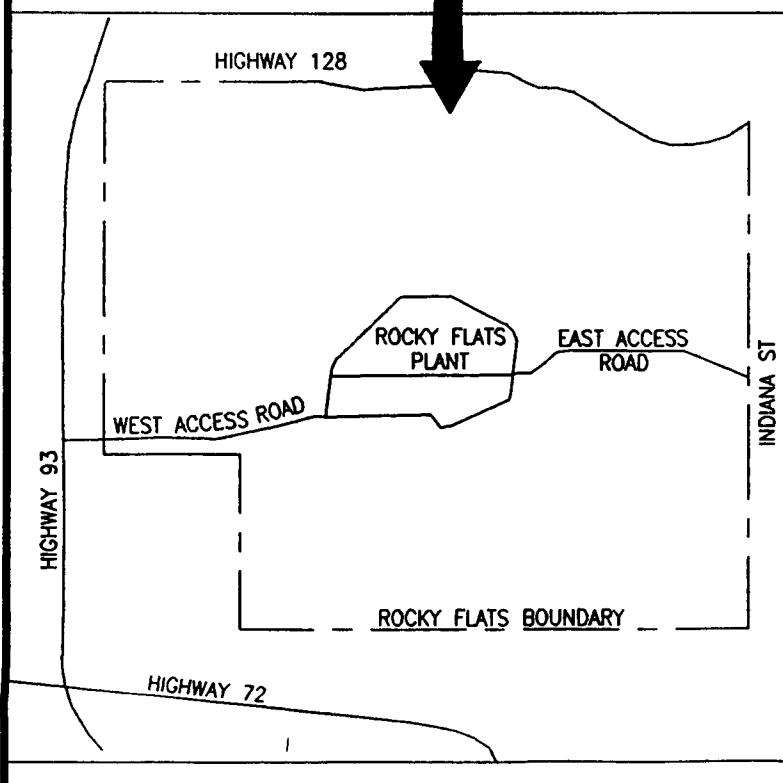
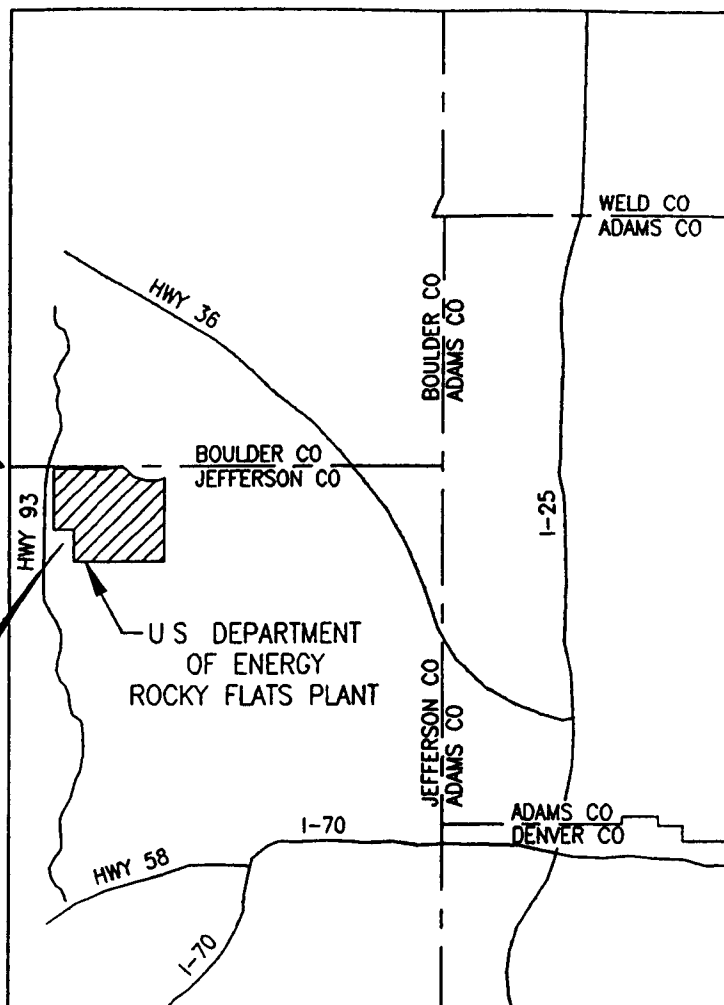
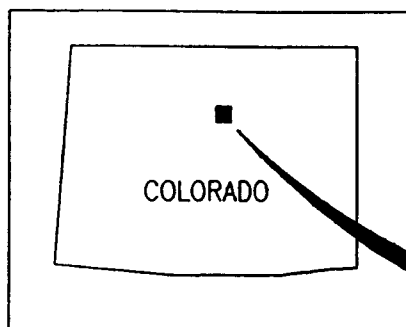
4.2.13 Mound Site (IHSS 113)

The Mound Site (IHSS 113) is located north of Trench T-1 (IHSS 108), east of the PA fence, south of South Walnut Creek, and west of the inner east gate (Figure 1 1-3) The Mound Site was reportedly used as a disposal site between 1954 and 1958 for drums containing depleted uranium- and beryllium-contaminated hydraulic oil and CCl₄ Records indicate burial of drums in this site, some of which were also contaminated with enriched uranium and plutonium, and PCE Drums were removed from the site in 1970

Analytical data collected to date from the Mound Site indicate the presence of PCE and TCE, with increasing concentrations to a depth of approximately 20 to 30 feet, and then decreasing concentrations below that depth The PAH, fluoranthene, is present in near-surface samples The PCB, Aroclor-1254, was detected in two near-surface soil samples Elevated activities

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	22 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

for Am-241 and Pu-239/240 in the near surface samples indicate surface or near surface waste-related radionuclide contamination in the Mound Site (DOE 1993)



U.S. DEPARTMENT OF ENERGY
Rocky Flats Environmental Technology Site
Golden, Colorado

OU2 TRENCH CHARACTERIZATION

GENERAL LOCATION OF
ROCKY FLATS

FIGURE 4-1 December 1994

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	25 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

5.0 SCOPE OF WORK

This HASP covers activities associated with the OU-2 Trenches and Mound Site Characterization. The sampling and investigative activities are described in detail in the work plan and in the Rocky Flats Environmental Restoration Program Standard Operating Procedures (SOPs). The following sections summarize the sampling and investigative activities.

5.1 TASK 1 - MOBILIZATION

This task includes setting up support facilities in the designated area within the Contractor's yard. Temporary offices, storage trailers, and sanitary facilities will be supplied by Rocky Flats. Rocky Flats will also supply a shower facility for crews to complete the decontamination process at the end of the shift as appropriate. Power and potable water will be provided for the support facilities.

5.2 TASK 2 - NON-INTRUSIVE GEOPHYSICS

The location and boundaries of Trenches T-1, T-2, and T-4 through T-13 will be determined by reviewing historical aerial photographs and using geophysical methods. The geophysical methods selected for this purpose include electromagnetics (EM) and ground penetrating radar (GPR).

The EM survey will primarily be used to locate metal objects in the trench, to locate possible drums or other debris during intrusive activity, and to potentially identify trench materials from undisturbed areas. As resolution of EM results are only accurate to within a few feet, GPR will be employed to augment the EM data to locate the trench walls with greater accuracy.

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	26 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

5.3 TASK 3 - SOIL GAS SURVEY

A direct push rig will be used for collection of soil gas through probes placed in the trenches. Soil gas will not be sampled at the Mound Site. The survey will begin with a grid over each trench to guide subsequent soil sampling. Soil gas survey samples will be collected at two depths (5 and 10 feet bgs) at each sampling location. Soil gas samples will be extracted and screened in the field for total VOCs using a portable flame ionization detector (FID) and a photoionization detector (PID) to identify a VOC high concentration area. Ten percent of the samples will be sent to an off-site analytical laboratory for confirmation VOC analyses.

5.4 TASK 4 - SUBSURFACE SAMPLING

Subsurface material samples (including soil, sludge, or liquids) will be used to confirm VOC high concentration areas as well as characterize subsurface contaminant conditions in each trench using a direct push rig. Four boreholes will be drilled and sampled in the Mound Site to an approximate depth of 15 feet using hollow-stem auger drilling. Continuous core samples will be collected in each VOC high concentration area to a depth of approximately 10 feet, will be visually logged and will be screened using a portable FID and/or PID and hand held radiation detectors to identify VOC and radionuclide contaminated intervals. In addition to the samples collected for chemical characterization, soil samples will be collected from selected intervals for testing for geotechnical and geochemical parameters.

5.5 TASK 5 - DECONTAMINATION

Decontamination at Rocky Flats is designed to eliminate the transfer of contamination from one site to another, and to reduce the possibility of personnel coming into contact with contamination. Decontamination will include

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and	Page	27 of 80
Safety Plan	Effective Date	
	Organization	Environmental Restoration Program Div

- Personnel
- General Equipment
- Heavy Equipment

Refer to Rocky Flats ERPDM Operating Procedures FO 03, FO 04, and FO 06 for decontamination procedures and FO 05 and FO 07 for the handling of decontamination and rinse water

6.0 HAZARD ASSESSMENT

6.1 CHEMICAL HAZARDS

Table 6-1 presents the physicochemical characteristics for the chemicals of concern (COCs) at this site and their respective exposure limits. The Permissible Exposure Limit - Time Weighted Average (PEL-TWA) and the Threshold Limit Value - Time Weighted Average (TLV-TWA) are defined as the concentration of a chemical in air to which nearly all workers can be repeatedly exposed, day after day, for a normal 8-hour workday and a 40-hour workweek, without adverse effect. If presented, the exposure limits are the most recent published values. Material Safety Data Sheets (MSDS) for the primary COCs are included in Appendix B.

The primary exposure pathways of concern for the COCs at this site are inhalation of contaminated particles or vapors and skin absorption. The majority of the COCs are VOCs at normal ambient temperatures and could volatilize. Air monitoring will be performed to reduce the potential for exposure (Section 8.3). The COCs could also become airborne in the breathing zone as a result of dust-generating activities. Dust suppression techniques (i.e., water misting) shall be used as required to reduce airborne exposures.

Personnel may be exposed to accidental ingestion of contaminants by hand to mouth contact after contact with contaminated materials. Ingestion of contaminants will be controlled on the site by specific prohibitions (Section 8.6.7) and requirements for decontamination (Section 8.5.1).

Skin and eye contact with some of the constituents at the site may cause skin or mucous membrane irritation. Many of those constituents can be absorbed into the bloodstream through the skin or eyes. Any body area which comes in contact with contaminated materials will be washed with soap and rinsed immediately.

6.1.1 Volatile Organic Compounds (VOCs)

CCl₄, PCE, TCE, 1,1,1-trichloroethane (1,1,1-TCA), xylenes, chloroform, 1,2-dichloroethane (1,2-DCA), and methylene chloride are the major VOCs of concern based upon site history and analytical results (DOE 1993). The primary exposure route to these VOCs is inhalation of vapors. Common uses and symptoms of exposure to the VOCs of concern are as follows:

- PCE is used as a solvent and a degreaser. Symptoms of inhalation exposure include irritation of the eyes, nose, and respiratory tract, nausea and vomiting. PCE targets the central nervous system (CNS), liver and kidney.
- Carbon tetrachloride is used as a solvent. It is regarded as highly toxic. Symptoms of inhalation exposure include irritation of the eyes, nose and throat, dizziness, mental confusion and incoordination. It is suspected to be a carcinogen. Carbon tetrachloride targets the CNS, liver, kidney and lungs.
- TCE is used as a solvent, degreaser and for chemical synthesis. Symptoms of exposure include headaches, dizziness, nausea and vomiting, respiratory tract irritation and ventricular fibrillation. TCE targets the liver, kidney and CNS.
- 1,1,1-TCA is used as a degreaser, solvent and for dry cleaning. Symptoms of exposure include headaches, dizziness, incoordination, narcosis and slowed heart beat. Prolonged skin exposure can result in defatting dermatitis. 1,1,1-TCA targets the CNS, liver and kidney.
- Xylenes refers to total xylenes which includes the o-, m- and p-isomers. Xylenes are used as solvents, in paints and lacquers, as a degreaser and for chemical synthesis. Symptoms of exposure include conjunctivitis, irritation of the nose and throat, headaches, vertigo, narcosis and nausea. Prolonged skin exposure can result in defatting dermatitis. Xylenes target the CNS and liver.

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	30 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

- Chloroform is used as a cleaning agent and solvent and for pharmaceuticals. Symptoms of exposure include irritation of the eyes, nose and respiratory tract, dizziness, mental confusion and narcosis. Chloroform targets the CNS, liver, kidney and heart, and is a suspect human carcinogen.
- 1,2-DCA is used as a degreaser, paint remover, solvent and for chemical synthesis. It is regarded as highly toxic. Symptoms of exposure include dizziness, mental confusion, abdominal pain, respiratory tract irritation and narcosis. 1,2-DCA targets the CNS, liver and, if ingested, the gastrointestinal tract.
- Methylene chloride is used as a degreaser, solvent, and extractant. Symptoms of exposure include irritation of the eyes, headache, nausea, dizziness, and poor concentration. Methylene chloride targets the CNS, and is metabolized to carbon monoxide, which then forms carboxyhemoglobin. Methylene chloride is a suspect human carcinogen.

6.1.2 Polycyclic Aromatic Hydrocarbons

PAHs anticipated at these sites include benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene and others with similar characteristics. PAHs have low vapor pressures and will not present a vapor inhalation hazard. They may, however, be bound to soil particles and inhaled with airborne dusts. Dermal exposure to these compounds may cause health effects. Some of the constituents of PAHs are known carcinogens. For compound-specific information, see Table 6-1.

6.1.3 Polychlorinated Biphenyls (PCBs)

PCBs are a probable carcinogen. PCBs anticipated at these sites include Aroclor 1254. They are potent liver toxins and have low acute toxicity, but can accumulate in fatty tissue leading

to delayed health effects Exposure to these chemicals may occur through the dermal route if workers are in direct contact with soil or materials containing PCBs Ingestion of PCBs is possible, however, the probability of this route of exposure is greatly reduced by good personnel hygiene practices Due to the low vapor pressure of PCBs, inhalation of vapors is not a probable route of exposure Inhalation of PCBs bound to dust particles is possible, however, the probability of exposure is low

6.1.4 Metals

Arsenic

Arsenic is a toxic heavy metal Exposure to arsenic compounds targets the liver, kidneys, skin, lungs and lymphatic system Symptoms of exposure include dermatitis, ulceration of the nasal septum, hyperpigmentation of the skin, and degeneration of the peripheral nervous system Arsenic is considered to be a carcinogen Exposure to arsenic at these sites is expected to be limited to inhalation of dust particles containing arsenic However, the probability of exposure is low

Barium

Barium is a metal that is usually used in a soluble form for industrial purposes The soluble compounds are regarded as highly toxic Symptoms of exposure to the soluble salts include irritation of the eyes and mucous membranes Exposure to the insoluble compound may result in a pneumoconiosis with cough Exposure to barium at these sites is expected to be limited to inhalation of dust particles containing barium However, the probability of exposure is low

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	32 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

Beryllium

Beryllium is a metal used as an alloy and in ceramic products. It is regarded as highly toxic and is a suspect carcinogen. Symptoms of acute exposure include chemical pneumonitis, cough, chest pains, fatigue and rales. Chronic exposure is not anticipated at these sites and is expected to be limited to inhalation of dust particles containing beryllium. However, the probability of exposure is low.

Cadmium

Cadmium is a metal with a variety of industrial uses. Warning properties for cadmium dusts and fumes are considered "inadequate". Exposure to cadmium dusts targets the respiratory system, blood, kidneys, and prostate. Symptoms of chronic and acute exposure include shortness of breath, coughing, tightness in chest, pain below the sternum, fluid accumulation in the lungs, headaches, chills and muscle aches, nausea, diarrhea, loss or impairment of the sense of smell, emphysema, and anemia. Cadmium is considered a carcinogen. Exposure to cadmium at these sites is expected to be limited to inhalation of dust particles containing cadmium. However, the probability of exposure is low.

Chromium

Chromium is a metal which occurs in trivalent and hexavalent forms, and is used for alloys, stainless-steel, and protective coatings. Different chromium compounds have strong and varied colors. Exposure to chromium compounds targets the respiratory system and symptoms include fibrosis of the lungs. Hexavalent chromium is considered a carcinogen. Exposure to chromium at these sites is expected to be limited to inhalation of dust particles containing chromium. However, the probability of exposure is low.

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	33 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

Lead

Lead is a fairly common metal with a variety of industrial applications. The gastrointestinal tract, central nervous system, kidneys, reproductive system, blood, and gums are targets of lead exposure. Symptoms of exposure include lassitude, insomnia, constipation, abdominal pain, colic, anemia, hypertension, anorexia, low body weight, malnutrition, pallor, tremors and paralysis of the wrist. Exposure to lead at these sites is expected to be limited to inhalation of dust particles containing lead. However, the probability of exposure is low.

Mercury

Mercury is a metal that can be found as an organic and inorganic compound. Organic mercury compounds are found as colorless liquids and are used for antifouling paints, antiseptics, germicides and chemical synthesis and occur as aryl or alkyl compounds. The alkyl compounds are regarded as more hazardous than the aryl compounds. Symptoms of exposure to both include ataxia, hearing and vision disturbance, nausea, vomiting, and skin burns. The routes of exposure can be ingestion, inhalation, and skin absorption. Mercury targets the kidneys, eyes, skin, and CNS. Inorganic mercury compounds are found in various textures and colors, the metal is found as a silver liquid. Inorganic mercury and compounds are used in batteries, electrical switches, metal plating and paints. Symptoms of exposure to inorganic mercury and compounds include chest pains, headaches, fatigue and eye and skin irritation. Target organs are the same as for organic mercury compounds with the addition of the respiratory system. Routes of exposure can be ingestion, inhalation and skin absorption. Exposure to mercury at these sites is expected to be limited to inhalation of dust particles containing mercury. However, the probability of exposure is low.

Silver

Silver is a metal used as an alloy and for chemical synthesis. Symptoms of exposure to silver salts include conjunctivitis, respiratory tract irritation and skin burns. Exposure to silver at

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	34 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

these sites is expected to be limited to inhalation of dust particles containing silver. However, the probability of exposure is low.

6.2 RADIOLOGICAL HAZARDS

Current information about the OU-2 area indicates the presence of above-background and variable concentrations of the radionuclides Am-241, Pu-239/240 and possibly isotopes of uranium in surface soil. The trenches and mound site locations involved in this project would be subject to this surface soil contamination.

Above-background concentrations of Am-241, Pu-239/240, uranium-233/234 (U-233/234), U-235 and U-238 have been identified in subsurface soils for the trenches and mound site locations. Occasional above-background concentrations also have been identified for the radionuclides radium-226 (Ra-226), Ra-228, tritium (H-3), cesium-137 (Cs-137), and strontium-89, 90 (Sr-89,90), however the frequency of detection and/or pattern of distribution for these latter nuclides indicates that their presence may reflect the variation of background radioactivity.

Alpha, beta, x and/or gamma radiations are emitted by one or more of the radionuclides identified above for surface and subsurface potential contaminants. Alpha radiation is non-penetrating and is an internal hazard (i.e., hazardous only if the radioactive material emitting the radiation is taken into the body). Beta radiation is moderately penetrating and is both an internal hazard and an external hazard (i.e., the radioactive material is outside the body) to near-surface tissue such as the skin and the lens of the eyes. Gamma and x radiation can be highly penetrating and are both an internal hazard and an external hazard to the whole body.

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	35 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

The primary radiological hazard associated with this project is from the alpha radiation that could be associated with an intake of Am-241 or Pu-239/240 through inhalation, ingestion, or injection into a wound. Of these three pathways, inhalation and ingestion would be the most important. Dermal absorption would not be a significant pathway for the radionuclides involved.

At the radionuclide concentrations that have been measured at the work area, high radiation doses, which could result in acute radiation effects, would not occur. The primary hazard associated with low radiation doses is a possible increased risk of cancer. An increased risk of adverse hereditary and in utero exposure effects also may be associated with low radiation doses. The risk of intake of radioactive materials through inhalation is low and can be further minimized by avoiding unnecessary soil disturbance and resuspension. Full face air particulate respiratory protection is required if airborne radioactivity concentrations exceed prescribed threshold levels. The risk of intake through ingestion also is low and can be further minimized by following good hygienic practices such as wearing gloves, washing hands after working in contaminated soil areas, and not smoking, drinking, or eating in and around the contaminated areas.

Historical records indicate the possibility that pyrophoric uranium chips have been disposed in Trench T-1. Intrusive activities in Trench T-1 could present a fire hazard from this material. If the geophysical surveys confirm drums exist in Trench T-1, no intrusive activities are to be performed without an addendum reassessing the hazards and controls for this work.

6.3 PHYSICAL HAZARDS

6.3.1 Drilling

Personnel should be aware of wind directions and attempt to coordinate field activities and gasoline-powered equipment so that exhaust fumes and chemical vapors are located downwind from work areas

The hazards involved with the use of drill rigs are significant and include the hazards of pinch points, entrapment in machinery, impact from moving parts, fatigue, electrocution from lightening, overhead wires or buried utilities and improper operations. Using hand tools, moving the rig, and conducting required repairs can increase physical risks. Working with and around a drill rig can involve a high risk of serious injury or death.

6.3.2 Noise Exposure

Work at these sites will be conducted with high noise levels from drill rigs. Excessive noise exposure can cause both temporary and permanent effects on hearing. The temporary effects of excessive noise include ringing in the ears, interference with communication, and hearing threshold changes. The effect of long-term excessive noise includes varying degrees of noise induced hearing loss. Regulations require that hearing protection be used when noise levels exceed 85 decibels (dBA) averaged over an 8-hour day. Hearing protection is required at this site for exposures of greater than 85 dBA for any length of time. In the absence of instrumentation, an appropriate rule of thumb is that when normal conversation is difficult at a distance of 2 to 3 feet, hearing protection is required. However, noise monitoring will be performed (see Section 8.3) to determine employee exposure.

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	37 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

6.3.3 Heat and Cold Stress

Warm temperatures and high humidity could occur during work at these sites. Cold temperatures could also occur during work at these sites. These environmental conditions increase the risk of heat or cold stress during field activities. Monitoring will be conducted for exposure to heat and cold stress with the action levels and work/rest regimen being based on the latest published values by the American Conference of Governmental Industrial Hygienists (ACGIH) (Appendix C).

6.3.4 Personal Protective Equipment (PPE)

The PPE which may be required for some activities (coveralls and respirators) places a physical strain on the wearer. When PPE such as respirators, gloves, and protective clothing are worn, visibility, hearing, and manual dexterity are impaired. The risk of heat stress may increase depending on the level of PPE required.

6.3.5 Overhead Hazards

Special precautions must be taken when operating machinery (i.e., drill rigs) in the vicinity of overhead electrical power lines. Contact with electricity can shock, burn, and result in death. All overhead electrical power lines are considered to be energized and dangerous.

6.3.6 Traffic Hazards

Work activities to be performed at Trenches T-13 and T-12 may be conducted on an established road presenting a traffic hazard. The requirements presented in Section 8.1 will be followed to reduce the potential for employees to be exposed to traffic hazards.

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	38 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

6.4 BIOLOGICAL HAZARDS

During field work at this site, personnel may encounter a wide variety of insects including bees, mosquitos, and spiders. Field personnel are encouraged to use insect repellent when mosquitos are present.

Stings of bees and wasps may cause serious allergic reactions in certain individuals. Personnel with known insect allergies or sensitivities should notify the SSHO before field work begins.

Ticks are parasites that feed on the blood of an animal/human host and can carry several severe diseases, the least severe bringing several days of fever and pain and the worst causing brain damage. Specific precautions for avoiding ticks and symptoms of exposure to tickborne diseases are presented in Appendix D.

Poisonous snakes or spiders may also be encountered on site. Personnel should check for snakes before walking through grassy or debris-strewn areas. Care should be taken when lifting possible habitats of snakes and spiders such as debris and cover. If a person is bitten by snake or spider, the victim shall be transported to the nearest emergency facility or hospital.

6.5 TASK BY TASK HAZARD ANALYSIS

Table 6-2 presents a task by task hazard analysis for each location based on the hazards listed in the above sections. The hazard evaluation for each activity is based on the following criteria:

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	39 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

- Low - activities are likely to result in no exposure to hazards
- Moderate - activities are likely to result in hazard exposure below established exposure limits
- High - activities are likely to result in hazard exposures near or above established exposure limits

The locations are categorized as follows based on historical information for the trenches and mound site surface and subsurface contamination identified to date

- Trenches T-1, T-2 and T-4 - Location I
- Trenches T-5 through T-9 - Location II
- Trenches T-10, T-11, Mound Site, - Location III
- Trenches T-12 and T-13 - Location IV
- Contractor's Yard - Location V

TABLE 6-1
PHYSIOCHEMICAL CHARACTERISTICS OF CHEMICALS OF CONCERN

	OSHA PEL	ACGIH TLV/ Recommended Exposure Limits	IDLH	Highest Detected Concentration	Vapor Pressure	Skin Hazard	Odor Threshold	Carcinogen Category	Ionization Potential
					mm @ 68 F				eV
Aroclor 1254 (Polychlorinated Biphenyl, 54% chlorine)	0.5 mg/m ³	0.5 mg/m ³	5 mg/m ³	6.9 mg/kg	0.00006	YES	~odorless	IRIS B2	
Arsenic (Inorganic)(Metal)	0.01 mg/m ³	0.01 mg/m ³	100 mg/m ³	26 mg/kg	0.097	NO	~odorless	IRIS A	
Barium	0.5 mg/m ³	0.5 mg/m ³	1100 mg/m ³	413 mg/kg	0.35	NO	~odorless	NE	
Benzo(a)anthracene	0.2 mg/m ³ (b)	0.2 mg/m ³ (b)	NE	530 mg/kg	5.00E-09				
Benzo(a)pyrene	0.2 mg/m ³ (b)	0.2 mg/m ³ (b)	NE	480 mg/kg	5.00E-09	YES	faint aroma	IRIS B2	
Benzo(b)fluoranthene	0.2 mg/m ³ (b)	0.2 mg/m ³ (b)	NE	820 mg/kg	~0	YES		IRIS B2	
Benzo(g,h,i)perylene, methyl	0.2 mg/m ³ (b)	0.2 mg/m ³ (b)	NE	360 mg/kg	1.00E-10			IRIS D	
Cadmium (dust)	0.05 mg/m ³	0.01 mg/m ³ T(a) 0.002 mg/m ³ R(a)	50 mg/m ³	6.2 mg/kg	0.09	NO	~odorless	IRIS B1	
Carbon Tetrachloride	2 ppm	5 ppm	300 ppm	62.9 mg/kg	91	YES	sweet, aromatic 21.4 ppm	IRIS B2	11.47

TABLE 6-1
PHYSIOCHEMICAL CHARACTERISTICS OF CHEMICALS OF CONCERN

	OSHA PEL	ACGIH TLV/ Recommended Exposure Limits	IDLH	Highest Detected Concentration	Vapor Pressure	Skin Hazard	Odor Threshold	Carcinogen Category	Ionization Potential
Chloroform	2 ppm	10 ppm	1000 ppm	534 mg/kg	160	NO	pleasant 130 1000 ppm	IRIS B2	11 42
Chromium (metal)	1 mg/m ³	0 5 mg/m ³	NE	127 mg/kg	0 02	NO	~odorless	NE	
DDT (Dichlorodiphenyltrichloroethane)	1 mg/m ³	1 mg/m ³	NE	140 mg/kg	0 00000015	YES	fruit-like, aromatic 0 35 ppm in water	IRIS B2	
Dichloroethane 1 2-	1 ppm 2 ppm S	10 ppm	1000 ppm	010 mg/kg	64	YES	Chloroform-like olfactory develops tolerance	IRIS B2	11 05
Indeno(1,2,3-c,d)pyrene	0 2 mg/m ³ (b)	0 2 mg/m ³ (b)	NE	330 mg/kg	~0	YES		IRIS B2	
Lead (inorganic)	0 05 mg/m ³	0 15 mg/m ³	700 mg/m ³	86 4 mg/kg	0 04	NO	~odorless	IRIS B2	
Mercury (organo) alkyl compounds (as Hg)	0 01 mg/m ³ 0 03 mg/m ³ S	0 01 mg/m ³ 0 03 mg/m ³ S	10 mg/m ³	6 mg/kg	varies	YES		IRIS D	
Methyl Chloroform (1,1,1 Trichloroethane)	350 ppm 450 ppm S	350 ppm 450 ppm S	1000 ppm	8 mg/kg	100	NO			11 00
Methylene Chloride	500 ppm	50 ppm	5000 ppm	5 7 mg/kg	350	NO	sweet, pleasant 160 307 ppm	IRIS B2	11 32
Silver	0 01 mg/m ³	0 1 mg/m ³	NE	96 5 mg/kg	0 03	NO		IRIS D	

TABLE 6-1
PHYSIOCHEMICAL CHARACTERISTICS OF CHEMICALS OF CONCERN

	OSHA PEL	ACGIH TLV/ Recommended Exposure Limits	IDLH	Highest Detected Concentration	Vapor Pressure	Skin Hazard	Odor Threshold	Carcinogen Category	Ionization Potential
Tetrachloroethylene (Perchloroethylene)	25 ppm	25 ppm 100 ppm S	500 ppm	543 mg/kg	14	NO	mildly sweet desensitizes olfactory 4.68 - 50 ppm	IARC 2B	9.32
Trichloroethylene	50 ppm 200 ppm S	50 ppm 100 ppm S	1000 ppm	18.3 mg/kg	58	NO	sweet chloroform 21.4 ppm	IARC 3	9.45
Xylene, all isomers	100 ppm 150 ppm S	100 ppm 150 ppm S	1000 ppm	1.2 mg/kg	9	NO	aromatic	IRIS D	8.44 - 8.56

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	43 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

TABLE 6-1
PHYSIOCHEMICAL CHARACTERISTICS OF CHEMICALS OF CONCERN

NOTES

a	=	These TLVs have not yet been adopted	ACGIH has placed them under notice of intended changes
ACGIH	=	American Conference of Governmental Industrial Hygienists	
b	=	This PEL/TLV is for all Coal Tar Pitch Volatiles combined	Separate PEL/TLVs have not been established to date
c	=	These PEL/TLVs have not been established	The compounds are considered less toxic than Phenol and the odor thresholds are low enough
C	=	Ceiling Limit, shall not be exceeded at any time during the work day	to indicate exposure if the PEL for Phenol is adopted for these compounds
CAS #	=	Chemical Abstracts Service Registry Number	
D	=	Contaminant intake that should not induce adverse effects to human health or should not pose a risk of cancer occurrence greater than a predetermined risk level	
		Developed by US Army Medical Bioengineering R&D Laboratory	Expressed in mg/kg/day
IARC	=	International Agency For Research on Cancer	
IDLH	=	Immediately Dangerous to Life or Health	
IRIS	=	Integrated Risk Information System	
LOAEL	=	Lowest-Observed -Adverse Effect Level as determined by the USEPA/1989	
LTE	=	Long Term Exposure Limit greater than 14 days as determined by USEPA/1989	
ME	=	Molecular weight	

**TABLE 6-1
PHYSIOCHEMICAL CHARACTERISTICS OF CHEMICALS OF CONCERN**

mg/m ³	=	milligrams of contaminant per cubic meter of air
NA	=	Not Applicable
NE	=	Not Established
OSHA	=	Occupational Safety and Health Administration
PEL	=	Permissible Exposure Limit, unless noted is the TWA, Time Weighted Average (usually for 8 hours a day, 5 days a week), mandated by law
ppm	=	parts of contaminant per million parts of air
R	=	Respirable Dust
Rfd	=	Chronic Oral Reference Dose as determined by the USEPA/1989
S	=	Short Term Exposure Limit (STEL) not to exceed 15 minutes, four times in one day with at least 60 minutes between each exposure
S/5/2	=	STEL for 5 minutes, twice per day
Skin Hazard	=	Contaminant can be absorbed through intact skin
STE	=	Short Term Exposure less than 14 days for minimal risk other than cancer as determined by USEPA/1989
T	=	Total Dust
TLV	=	Threshold Limit Value, unless noted is the TWA, Time Weighted Average (usually for 8 hours a day, 5 days a week), recommended

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site Characterization Site Health and Safety Plan	Section No	
	Page	45 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

TABLE 6-1
PHYSIOCHEMICAL CHARACTERISTICS OF CHEMICALS OF CONCERN

Carcinogenic Category	
IRIS	
IARC	
A 1	Human Carcinogen
B1 2A	Probable Human Carcinogen (limited human data)
B2 2B	Probable Human Carcinogen (sufficient in animals, inadequate evidence in humans)
C 3	Possible Human Carcinogen
D 4	Not Classifiable
E	Evidence of Non-Carcinogen

**TABLE 6-2
TASK BY TASK HAZARD ANALYSIS**

Location/ Hazard	Task 1 - Mobilization	Task 2 - Non-intrusive Geophysics	Task 3 - Soil Gas Survey	Task 4 - Subsurface Sampling	Task 5 - Decontamination
Location I					
Chemical	NA	Low	Low	Moderate	Low
Physical	NA	Low	Moderate	Moderate	Low
Biological	NA	Low	Low	Low	Low
Radiological	NA	Moderate	Moderate	Moderate	Moderate
Location II					
Chemical	NA	Low	Low	Moderate	Low
Physical	NA	Low	Moderate	Moderate	Low
Biological	NA	Low	Low	Low	Low
Radiological	NA	Moderate	Moderate	Moderate	Low
Location III					
Chemical	NA	Low	Low	Moderate	Low
Physical	NA	Low	Moderate	Moderate	Low
Biological	NA	Low	Low	Low	Low
Radiological	NA	Low	Low	Low	Low
Location IV					
Chemical	NA	Low	Low	Moderate	Low
Physical	NA	Low	Moderate	Moderate	Low
Biological	NA	Low	Low	Low	Low
Radiological	NA	Low	Low	Low	Low
Location V					
Chemical	Low	NA	NA	NA	NA
Physical	Low	NA	NA	NA	NA
Biological	Low	NA	NA	NA	NA
Radiological	Low	NA	NA	NA	NA

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	47 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

7.0 GENERAL HEALTH AND SAFETY REQUIREMENTS

All on-site employees who are required to work in the Exclusion Zone (EZ) (see Section 8.1) must obtain health and safety clearance by the W-C SSHO before beginning work at this site.

7.1 MEDICAL SURVEILLANCE

Personnel assigned to field activities must participate in a medical surveillance program, in accordance with 29 CFR 1910.120 (f), with subsequent certification by an occupational physician of physical fitness and ability to perform assigned field work, including the ability to wear a respirator.

Workers on site for a specific limited task (e.g., delivery personnel), and who are unlikely to be exposed to levels over the permissible exposure limits, can receive a minimum of 24-hours of instruction on OSHA requirements.

Radiation dosimeters and bioassay testing will be furnished by Rocky Flats as necessary for personnel working on this project.

7.2 SAFETY TRAINING

Employees shall not participate in field activities until they have been trained to a level required by their job function and responsibility. Trainers shall have received a level of training higher than and including the subject matter of the level of instruction they are providing. All training and field experience shall be certified. Training requirements are discussed below.

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	48 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

7.2.1 40-hour Basic Training

Personal assigned to field activities must have completed the 40-hour basic health and safety training required under 29 CFR 1910.120 and have received 8-hour annual refresher training thereafter

7.2.2 Three-day On-site Supervision

Personal assigned to field activities shall be required to receive a minimum of 3 days of on-site training under the supervision of a trained and experienced supervisor. On-site time under supervision shall be documented.

7.2.3 Radiation Safety Course

All field employees shall be required to receive a Rocky Flats radiation worker safety course as appropriate for their level of work.

7.2.4 On-site Supervisor

The on-site supervisor (site manager) must have completed the basic 40-hour training course, 3 days of on-site supervision, and at least 8 hours of specialized training on managing hazardous waste operations. The 8 hours of specialized training shall include instruction covering the W-C health and safety program, employee training program, personal protective equipment program, spill containment procedures, and health hazard monitoring procedures and techniques.

7.2.5 Site Safety and Health Officer (SSHO)

The Site Safety and Health Officer must have completed the 40-hour training, 3-day on-site supervision, first aid and cardiopulmonary resuscitation (CPR) training.

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	49 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

7.2.6 Health and Safety Technician (HST)

The HST must have completed the 40-hour training, 3-day onsite supervision, first aid and cardiopulmonary resuscitation (CPR) training

7.3 SITE SPECIFIC SAFETY BRIEFING

A site-specific safety briefing shall be conducted for all employees, including subcontractors, prior to commencement of field activities. The following topics will be discussed at this meeting

- Names of health and safety personnel and alternates responsible for site health and safety
- Health and safety organization
- Hazards at the site
- Exposure risk
- Personal protective equipment to be used
- Personnel and equipment decontamination procedures
- Air monitoring
- Emergency procedures

All field personnel must read a copy of this Health and Safety Plan. At the end of the meeting, attendees should be informally quizzed to assess their understanding of the health and safety requirements, and should sign a safety compliance agreement form stating that they have read, understand, and agree to comply with the provisions of the plan. Anyone refusing to sign the form will be prohibited from working at the site.

If a new employee who has not gone through the site-specific safety orientation meeting is assigned to the site, the SSHO must present a similar briefing to the new employee before

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	50 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

he or she participates in any field activities All new employees must sign the safety compliance agreement form before beginning fieldwork at Rocky Flats

7.4 ACCIDENT/INCIDENT REPORTING

7.4.1 W-C Procedures

In the event of an accident or incident, the SSHO will immediately notify the W-C Project Manager, HSO, and CHSO Types of accidents or incidents that are considered reportable are

- Illness resulting from chemical exposure or unknown causes
- Physical injury, including an injury that does not require medical attention
- Fire, explosions, and flashes resulting from activities performed by W-C and subcontractors
- Infractions of safety rules and requirements
- Unexpected chemical/radiological exposures
- Vehicular accident
- Property damage accidents

Work will be suspended to correct the cause of the accident/incident and to modify this plan as necessary

A W-C accident/incident report form must be submitted to the Project Manager (PM) and HSO within 24 hours of occurrence

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	51 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

7.4.2 Rocky Flats Procedures

The SSHO will notify the W-C Project Manager, the Rocky Flats Environmental Restoration (ER) Health and Safety Officer, the Rocky Flats ER Project Manager, and the Rocky Flats Area Construction Engineer of any accidents or incidents that occur during field activities. The SSHO will also submit a completed DOE Form F 5484 X for any of the following incidents:

- 1 "Recordable" occupational injuries or illnesses as defined below

OCCUPATIONAL INJURY is any injury such as a cut, fracture, sprain, or amputation that results from a work accident or from an exposure involving a single incident in the work environment that requires more than standard first aid. NOTE: Conditions resulting from animal or insect bites, or one-time exposure to chemicals, are considered to be injuries.

OCCUPATIONAL ILLNESS of an employee is any abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors associated with employment. It includes acute and chronic illnesses or diseases that may be caused by inhalation, absorption, ingestion, or direct contact with a toxic material.

- 2 PROPERTY DAMAGE LOSSES of \$1,000 or more are reported as follows: accidents that cause damage to DOE property, regardless of fault, or accident wherein DOE may be liable for damage to a second party, are reportable if damage is \$1,000 or more. Include damage to facilities, inventories, equipment, and properly parked motor vehicles. Exclude damage resulting from a DOE reportable vehicle accident.

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	52 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

3 GOVERNMENT MOTOR VEHICLE ACCIDENTS resulting in damages of \$250 or more, or involving injury, are reported unless the government vehicle is not at fault, damage of less than \$250 is sustained by the government vehicle, and no injury is inflicted on the government vehicle occupants. Accidents are also reportable to DOE if

- Damage to DOE property is greater than or equal to \$250 and the driver of a government vehicle is at fault
- Damage to any private property or vehicle is greater than or equal to \$250 and the driver of a government vehicle is at fault
- Any person is injured and the driver of a government vehicle is at fault

7.5 VISITOR CLEARANCES

All visitors to the site must be cleared by Rocky Flats security personnel. All visitors to the work site will be escorted by W-C or operating contractor personnel, if necessary. Any visitor to the work site will be given a site-specific safety orientation by the SSHO as described in Section 7.3. Prior to entering a work site, visitors will provide the SSHO with documentation of training required by Section 7.2. Any visitors who do not provide documentation will not be allowed into the EZ or contamination reduction zone (CRZ) (see Section 8.1).

7.6 HEALTH AND SAFETY LOGBOOK

A separate health and safety logbook and sign in/sign out log shall be maintained by the SSHO throughout the project and turned in to the HSO after the project is completed. Logged information shall include (1) names of all W-C and subcontract personnel entering

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	53 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

and leaving the work sites each day, (2) daily listing of work sites to be visited by field teams, (3) description of unforeseen hazards and steps taken to mitigate hazards, (4) summary of telephone conversations regarding health and safety, (5) safety infractions, if any, (6) accidents and injuries, and (7) all other significant health and safety items

7.7 SAFETY COMPLETION REPORT

The W-C SSHO will prepare a safety completion report at the end of field activities. The report will include a critical review of this plan, exposure monitoring data with monitoring dates and any decisions made based on that data, a summary of incidents and action taken, and recommendations for improving health and safety at similar sites. This report form is in Appendix E.

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	54 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

8.0 SITE-SPECIFIC HEALTH AND SAFETY REQUIREMENTS

8.1 WORK ZONES

The site will be divided into three basic zones (1) Exclusion Zone, (2) Contamination Reduction Zone, and (3) the Support Zone. The EZ includes areas of high physical, chemical, or radiological hazards. Only authorized personnel are permitted within the EZs. Examples of EZs are a 40-foot radius around any intrusive activity or areas where hard hats or respiratory protection is required. The EZ will be clearly marked with traffic cones, banner tape, or other high visibility markings, and in accordance with EMRG 13 and 91, for radiological hazards.

The Contamination Reduction Zone (CRZ) or decontamination area is the corridor through which all authorized personnel may enter or exit from the exclusion zone. The CRZ contains decontamination equipment and containers for disposable outerwear, etc. The CRZ is located on the upwind side of the EZ. Entrances and exits are clearly marked with high visibility items such as traffic cones, banner tape or other high visibility markings.

The Support Zone (SZ) contains personnel who perform support functions for the physical work and a break area. It is upwind of the CRZ. Managers, spare equipment, etc., are generally located in the SZ. All personnel exiting the EZ must be decontaminated prior to entering the SZ. Heat stress monitoring is performed in the SZ.

Work sites that will be located on an established road will require traffic hazard controls. These controls will be detailed in a traffic control plan and approved by Rocky Flats Fire Department and Occupational Safety prior to work being performed at sites covered by this paragraph.

Contamination prevention techniques will be used wherever feasible. Monitoring equipment will be wrapped in plastic to prevent possible contamination and to minimize

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	55 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

decontamination, to the extent possible, without interfering with their function The plastic will be discarded as contaminated waste after each day's use

8.2 PERSONAL PROTECTIVE EQUIPMENT

PPE will be worn during field activities The specifications for the levels of PPE that may be required are shown in Table 8-1 The initial levels of PPE are shown below The SSHO may modify these initial levels of PPE in response to additional site information, with the approval of the HSO

- Task 1 - Mobilization - Level D
- Task 2 - Non-Intrusive Geophysics - Level D*
- Task 3 - Soil Gas Survey - Modified Level D
- Task 4 - Subsurface Sampling - Level B
- Task 5 - Decontamination - Based upon monitoring performed during above tasks, and specific to each location

* or as determined by the Radiological Work Permit (RWP)

8.3 MONITORING REQUIREMENTS

Direct-reading real-time monitoring will be conducted in accordance with Table 8-3

- A organic vapor detector (OVD) (photoionization [PID]) with an 11 7eV lamp (or higher) and a Sensidyne pump with detector tubes for carbon tetrachloride, chloroform, and 1,2-DCA will be used to monitor for nonradioactive substances

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	56 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

- A Bicron Frisk tech with an A-100 probe and a Ludlum Model 31 with a 44-9 probe (or equivalent) will be used to monitor equipment surfaces and PPE for the presence of fixed and removable radioisotopes. A Bicron FIDLER with a G-5 probe will be used to monitor prior to any intrusive activities.
- A MiniRam will be used to monitor airborne dust levels of radioactive substances, metals, and PCBs.
- A wet bulb glove thermometer (WBGT) will be used to monitor environmental factors contributing to heat stress.
- A sound level meter and noise dosimetry will be used to measure sound levels that workers are exposed to.
- A personal sampling pump will be used to conduct personal integrated sampling for volatiles and heavy metals. Integrated samples for heavy metals and PCBs will be collected whenever airborne dust concentrations exceed 5 mg/m³. Sampling for volatile contaminants will be conducted during drilling operations. It is anticipated that the PEL will not be exceeded during the collection of soil-gas samples. During the subsurface sampling, the sample location with the greatest potential for worker exposure, based on the soil-gas survey, will be the location for the personal integrated sampling at each trench.

8.3.1 Monitoring Calibration and Documentation

The PID, sound level meter, noise dosimeter, Ludlum, Bicron meter and MiniRam will be calibrated and/or performance checked, at least once each day it is in use, and operated according to the manufacturer's guidelines. A calibration record is provided in Appendix F. The action levels for the PID listed in Table 8-2 are based upon the use of isobutylene as a calibration gas. The instrument shall be calibrated to the isobutylene standard. Sampling

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	57 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

pumps shall be calibrated each day before and after sampling. Response checks will be completed as necessary. A calibration and sampling record is included in Appendix G.

Daily instrument readouts will be maintained by the SSHO. A report summarizing monitoring results must be written as part of the safety completion report at the end of this project. At a minimum, a record of all breathing zone concentrations, as measured by approved field personnel, is to be included in the monitoring report.

Calibration records and records of exposure will be maintained in the project health and safety file.

8.4 ACTION LEVELS

Acceptable limits for contaminants on this site are those recommended in the most recent Permissible Exposure Limits (PEL), listed in 29 CFR 1910.1000 and/or ACGIH "Threshold Limit Values (TLV) for Chemical Substances and Physical Agents and Biological Exposure Indices". Action levels will be set at no more than half of the more restrictive value, PEL or TLV. It is assumed that contaminants with low vapor pressures would not be detected by the PID. The acceptable limits for radionuclides are listed in 10 CFR 835 Occupational Radiological Protection. Minimum action levels for changes in PPE levels and for stop work requirements are shown in Table 8-2.

8.5 DECONTAMINATION

8.5.1 Personnel Decontamination

Personnel exiting the EZ will be decontaminated before leaving the CRZ. Primary decontamination will be done at the border of the EZ and CRZ. Between the EZ and SZ, the personal CRZ provides a transition zone between the contaminated and clean areas of the site.

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	58 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

The SZ is an uncontaminated area from which operations will be directed. It is essential that contamination from the site be kept out of this area.

Decontamination for Level D PPE will include washing boots. Disposable coveralls, gloves or outer boot coverings, if worn, will be discarded in the appropriate drum. If cotton coveralls or work clothes are worn, they will be removed prior to leaving the site and street clothes will be donned. Personnel are advised to shower as soon as possible after leaving the site.

Decontamination for Modified Level D, Level C and Level B will be as follows:

- Wash boot covers and outer gloves with a long-handled brush in a wash tub containing detergent water.
- Rinse boot covers and outer gloves with water using a long-handled brush in a wash tub containing potable water or by using a sprayer if available.
- Remove tape used to seal the gloves and boots and place in the dedicated disposal drum for PPE.
- Remove Tyvek®, coated Tyvek or equivalent coveralls (for Level B remove outer coveralls) in the PPE disposal drum.
- Remove boot covers and place in the PPE disposal drum.
- Remove outer gloves and place in the PPE disposal drum.
- Boots will be inspected and checked for further decontamination, as needed.

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	59 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

- Remove respirators or face masks and place on the equipment table for decontamination
- Remove inner coveralls (Level B) and place in the PPE disposal drum
- Place inner gloves in the PPE disposal drum If cold weather liners are used, place them in a dedicated receptacle for machine washing and subsequent reuse
- Personnel will be transported to the shower and locker room or change out facility for personal washing with soap and water

NOTE The water repellency of non-coated Tyvek and similar garments is due to the surface tension of water and the resistance of the Tyvek fiber to wetting The presence of surfactants (e g , detergents) in the water completely defeats the water-repellent properties of Tyvek Therefore, non-coated Tyvek and similar fabrics should never be exposed to detergent and water solutions during the decontamination process

8.5.2 Equipment Decontamination

Equipment decontamination is included in Rocky Flats ERPDM operating procedures FO 03, FO 04 and FO 06 The handling of decontamination water is in FO 05 and FO 07

8.6 WORK PRACTICES

8.6.1 Drilling Safety

The Woodward-Clyde Operating Procedure HS 203 Safe Guidelines for Drilling into Rocks and Soils will be followed during all augering operations

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	60 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

8.6.2 Confined Space Entry

Confined space entry is not authorized for this project. If it is determined during the course of field activities that a confined space entry is required, an addendum to this HASP will be required.

8.6.3 Spill Containment Plan

A review of the work to be performed at these sites and the materials to be used shows that spills likely to occur at this site would be limited to decontamination fluids. These spills will be highly unlikely. Should a spill of hazardous materials occur onsite, the Rocky Flats hazardous materials response team will be summoned, and Rocky Flats project personnel will be notified. However, absorbent socks or other materials will be kept onsite as a temporary response to spills.

8.6.4 Dust Control Measures

Airborne dust concentrations are to be controlled during all activities which are intrusive into potentially contaminated soils. A small hand sprayer will be used to moisten soils and decrease airborne dust generation. A MiniRam will be used to monitor the area and the action levels found in Table 8-2 will be strictly followed.

8.6.5 Buddy System

The "buddy system" will be used during field work requiring the use of Modified Level D PPE or greater. As part of the buddy system, personnel will not enter or leave an EZ alone.

Rocky Flats Environmental Technology Site	Document No Section No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Page	61 of 80
Characterization Site Health and Safety Plan	Effective Date Organization	Environmental Restoration Program Div

8.6.6 Communications

Radios for on-site communication and telephones for off-site official communication will be available

8.6.7 Prohibited Activities

The following activities are prohibited

- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of material is prohibited except in designated areas Prescribed drugs should not be taken by personnel on operations where the potential for absorption, inhalation or ingestion of toxic substances exists unless specifically approved by a qualified physician Good personal hygiene should be practiced by field personnel to avoid ingestion of contaminants or spread of contaminated materials
- Smoking, lighters, and matches will be prohibited on site except for designated smoking areas
- No facial hair which interferes with a satisfactory fit of the mask-to face seal is allowed on personnel required to wear respirator or self-contained breathing apparatus
- Contact lenses are prohibited in the exclusion zone

8.6.8 Illumination

Night work is not anticipated during this project If night work is required, work will be performed in compliance with 29 CFR 1926.56 - Illumination

Rocky Flats Environmental Technology Site OU-2 Trenches and Mound Site Characterization Site Health and Safety Plan	Document No Section No Page Effective Date Organization Environmental Restoration Program Div	RF/ER-95-0011 62 of 80
---	---	-----------------------------------

8.6.9 Sanitation

Potable water and toilet facilities which comply with 29 CFR 1910 120(n) must be available to on-site personnel

TABLE 8-1
PPE LEVELS

USEPA PPE Level	Required PPE
B	<ul style="list-style-type: none">- Tyvek (or equivalent) inner coveralls- Coated Tyvek (or equivalent) coveralls, when working with liquids or sludges- Inner Nitrile gloves- Outer Nitrile gloves- Steel-toed shoes- Disposable shoe covers- Hard hat (where overhead hazards exist)- Airline or self contained breathing apparatus- Ear protection (in high noise areas)
C	<ul style="list-style-type: none">- Coated Tyvek (or equivalent) coveralls, when working with liquids or sludges- Tyvek (or equivalent) coveralls- Inner Nitrile gloves- Outer Nitrile gloves- Steel-toed shoes- Disposable shoe covers- Hard hat (where overhead hazards exist)- Full-face respirator with combination dust and organic vapor cartridges- Ear protection (in high noise areas)

TABLE 8-1
PPE LEVELS
(Continued)

USEPA PPE Level	Required PPE
Modified D	<ul style="list-style-type: none">- Tyvek (or equivalent) coveralls- Coated Tyvek (or equivalent) coveralls, when working with liquids or sludges- Nitrile gloves- Safety glasses with side shields- Steel-toed shoes- Disposable shoe covers (or equivalent)- Hard hat (where overhead hazards exist)- Ear protection (in high noise areas)
D	<ul style="list-style-type: none">- Disposable coveralls, cotton coveralls, or work clothes- Safety glasses with side shields- Steel-toed shoes- Hard hat (where overhead hazards exist)- Ear protection (in high noise areas)

TABLE 8-2

MONITORING ACTION LEVELS

Hazard	Instrument	Action Level	Action
Heat Stress	Pulse Check (heat stress)	50-110 beats per minute (bpm)	Continue work If approaching 110 bpm, reduce work load to minimize heat stress
		> 110 bpm	No field work permitted Rest in cool location Drink cool fluids
Heat Stress	WBGT	70°F	See Appendix C
Noise	Sound Level Meter	< 85 dBA	Site work may be conducted without hearing protection
		> 85 dBA	Hearing protection must be worn during site work, monitor with noise dosimeter
Organic Vapors	Photoionization Detector (PID)	0 ppm ¹	Level D, no respiratory protection required to be worn
		1-5 ppm ¹	Monitor area and personnel with Detector Tubes
		> 5 ppm ¹	Stop work and upgrade to Level C PPE
		> 10 ppm ¹	Withdraw from site or go to Level B protection
Carbon Tetrachloride	Detector Tubes	0-1 ppm ¹	Level D, no respiratory protection required to be worn
		> 1 ppm ¹	Withdraw from site or go to Level B protection
Chloroform	Detector Tubes	0-1 ppm ²	Level D, no respiratory protection required to be worn
		> 1 ppm ²	Withdraw from site or go to Level B protection
1,2-DCA	Detector Tubes	0 ppm ²	Level D, no respiratory protection required to be worn
		8 ppm ²	Withdraw from site or go to Level B protection
Dust (radioactive or metals contaminated)	Mini-RAM	< 0.04 mg/m ³	Respirators not required
		> 0.04 mg/m ³	Level C respiratory protection required
		> 0.25 mg/m ³	Stop work Call Health and Safety Specialist (HSS) Trigger level based on annual committed effective dose equivalent of 1.0 rem/yr assuming worst case soil concentration of 3590 pCi/g of plutonium
Alpha Radiation	Bicron Frisk Tech with A 100 probe (or as appropriate)	> 100 counts per minute (cpm)	Stop work and notify HSS
Low Energy X ray and Gamma Radiation	FIDLER - Bicron Analyst with a G 5 probe	> 3,000 cpm	Notify ER Radiological Engineer prior to performing any intrusive work

¹ Above background sustained for one minute in the breathing zone

² Reading taken at the borehole as a confirmation of the presence of 1,2-DCA and chloroform

TABLE 8-3
TASK AND LOCATION SPECIFIC
MONITORING REQUIREMENTS

TASK	LOCATION ¹	MONITORING REQUIREMENT ²
1 Mobilization	V	4
2 Non-Intrusive Geophysics	I, II, III, IV	3
3 Soil Gas Survey	I, II, III, IV	1, 2
4 Subsurface Sampling	I, II, III, IV	2
5 Decontamination	I, II, III, IV	2

¹ **Location:** I T-1/T-2/T-4 IV T-12/T-13
II T-5 thru T-9 V Contractor's Yard
III T-10/T-11, Mound Site

² **REQUIREMENT 1:** Prework monitoring of the work area will be conducted with a PID and FIDLER. The SSHO will determine the frequency and necessity of this monitoring based on site conditions and project needs. Instrument response shall be compared to the action levels shown in Table 8-2.

REQUIREMENT 2: The HST shall conduct the monitoring required for these tasks. Continuous area monitoring with a PID, Bicon Frisk tech and MiniRAM will be required during all intrusive activities required for these tasks. In addition, the HST shall periodically monitor the breathing zone of the workers with the greatest potential for exposure to the COCs. Frequency of breathing zone readings shall be determined by the SSHO based on site conditions. Instrument response shall be compared to the action levels shown in Table 8-2. Monitoring with the WBGT, sound level meter, and noise dosimeter will be performed by the SSHO as appropriate.

REQUIREMENT 3: Personnel and equipment monitoring with a Bicon Frisk tech and Ludlum 31 or equivalent will be conducted as needed. The SSHO will determine the frequency of monitoring for these tasks based on site conditions. Instrument response shall be compared to the action levels shown in Table 8-2.

REQUIREMENT 4: No monitoring is required.

9.0 EMERGENCY RESPONSE

9.1 EMERGENCY SERVICES

Procedures for emergency response are given in Section 9.2. The SSHO shall coordinate emergency response on site. The following phone numbers and directions shall be posted in a prominent location in the support zone. The SSHO shall confirm the location of and directions to the hospital and medical clinic. Any revisions to this section must be posted and all personnel notified of the changes.

The SSHO shall notify the hospital and the fire department of the activities to be conducted on site prior to initiation of field work. The emergency services shall be informed about the chemicals which have been detected on site and about any hazardous materials which have been brought on site. Copies of this plan and Material Safety Data Sheets shall be provided to them upon request.

9.1.1 Emergency Phone Numbers

In case of an emergency, the local emergency services must be notified. Emergency numbers for the hospital, fire department, and police are shown on Figure 9-1. These numbers shall be posted throughout the site and/or made accessible to each employee on site.

**ALL LIFE THREATENING EMERGENCIES:
DIAL 2911**

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	68 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

9.1.2 Rocky Flats Occupational Health Medical Facility (Building 122)

The Rocky Flats Medical Facility in Building 122 is to be used for major medical emergencies, until transport to Avista Hospital is possible. The medical facility is also for any contaminated personnel (i.e., radiological) with injuries, until decontamination is possible.

9.1.2.1 Directions to the Rocky Flats Occupational Health Medical Facility

From the Contractor's compound, take a northbound street to Central Avenue and turn left (west) onto Central Avenue. Continue for approximately 1.25 miles. Building 122 will be on the left (south) side of the guard building to the right. See map, Figure 9-2.

9.1.3 Avista Hospital

Avista Hospital is to be used for all other incidents requiring medical attention, for W-C or subcontractor personnel.

9.1.3.1 Directions to Avista Hospital

From the Contractor's compound, go north to Central Avenue and turn right (east) onto Central Avenue. Continue east to the east entrance to the plantsite, turn left (north) onto Indiana Street. At the intersection of Indiana Street and Highway 128, turn left (west). Continue west on Highway 128 to the intersection of McCaslin Boulevard. Turn right (north) onto McCaslin Boulevard. Continue north on McCaslin past the intersection with Highway 36 to Dillon Road. Turn right (east) on Dillon Road and continue to South 88th Street, then turn right (south). Turn right (west) on Health Park Drive and continue until it ends. The hospital is located at 100 Health Park Drive. See map, Figure 9-3.

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	69 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

9.2 EMERGENCY RESPONSE PROCEDURES

The Site Manager, with assistance from the SSHO, has responsibility and authority for coordinating all emergency response activities until proper authorities arrive and assume control

If an employee working in a contaminated area is physically injured, Red Cross first aid procedures will be followed. The SSHO or HST will provide the first aid. However, any site personnel that is trained and certified in first aid can provide first aid, if necessary. Depending on the severity of the injury, emergency medical response may be sought. If the employee can be moved, they will be taken to the edge of the work area (on a stretcher, if needed) where contaminated clothing will be removed (if possible) and emergency first aid administered, and then they will be transported to the hospital.

9.2.1 Emergency Medical Procedures

For severe injuries, illnesses, or overexposures

- Remove the injured or exposed person(s) from immediate danger
- If possible, at least partial decontamination should be completed. Wash, rinse, and/or cut off protective clothing and equipment and redress the victim in clean coveralls.
- If decontamination cannot be done, wrap the victim in blankets or plastic sheeting to reduce contamination of other personnel.
- Render emergency first aid and call an ambulance for transport to local hospital immediately. Notify emergency personnel of contaminants on site.

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	70 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

- Evacuate other personnel on site to a safe place until the SSHO determines that it is safe to resume work
- Report the accident to the PM and HSO immediately and complete an incident report

For minor injuries or illnesses

- Complete a full decontamination
- Administer first aid Minor injuries may be treated on site, but all injuries will be examined by trained medical personnel Victims of bites or stings will be taken to a medical center
- Notify the PM and HSO immediately

9.2.2 First Aid - Chemical Injury

If the injury to the worker is chemical in nature (e g , overexposure), the following first aid procedures are to be instituted as soon as possible

Eye Exposure If contaminated solid or liquid gets into the eyes, wash eyes immediately with sterile saline solution lifting the lower and upper lids occasionally Continue eye wash for 15 minutes Cover the eye with a dry pad and obtain medical attention immediately (Contact lenses are not permitted in the exclusion zone)

Skin Exposure If contaminated solid or liquid gets on the skin, promptly wash contaminated skin for 15 minutes using soap or mild detergent

and water If solids or liquid penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water Obtain medical attention immediately if symptoms warrant

Breathing If a person breathes in large amounts of organic vapor, move the exposed person to fresh air at once If breathing has stopped, perform artificial respiration Keep the affected person warm and at rest Obtain medical attention as soon as possible

Swallowing If contaminated solid or liquid has been swallowed, obtain medical attention immediately

9.2.3 First Aid - Physical Injury

Animal Bites Thoroughly wash the wound with soap and water Flush the area with running water and apply a sterile dressing Immobilize affected part until the victim has been attended by a physician See that the animal is kept alive and in quarantine, if possible Obtain name and address of the owner of the animal, if applicable

Burns (minor) Do not apply vaseline or grease of any kind Apply cold water applications until pain subsides Cover with a wet sterile gauze dressing Do not break blisters or remove tissue Seek medical attention

Burns (severe) Do not remove adhered particles of clothing Do not apply ice or immerse in cold water Do not apply ointment, grease or vaseline Cover burns with thick sterile dressings Keep burned feet or legs elevated Seek medical attention immediately

Cramps Treat as heat exhaustion See Appendix C

Cuts Apply pressure with sterile gauze dressing and elevate the area until bleeding stops Apply a bandage and obtain medical attention

Eyes Keep the victim from rubbing the eye Flush (foreign objects) the eye with water If flushing fails to remove the object, apply a dry, protective dressing and consult a physician

Fainting Keep the victim lying down with feet elevated Loosen tight clothing If victim vomits, roll him onto his side or turn his head to the side If necessary wipe out his mouth Maintain an open airway Bathe his face gently with cool water Unless recovery is prompt, seek medical attention

Fracture Deformity of an injured part usually means a fracture If fracture is suspected, splint the part as it lies Do not attempt to move the injured part of the person Seek medical attention immediately

Snake Bites Keep the bite area as low as possible Transport the victim immediately to a medical facility

Insect Bites	Remove "stinger" if present Keep affected part down below the level of the heart Apply ice bag For minor bites and stings apply soothing lotions, such as calamine
Puncture Wounds	If puncture wound is deeper than skin surface, seek medical attention Serious infection can arise unless proper treatment is received
Sprains	Elevate injured part and apply ice bag or cold packs Do not soak in hot water If pain and swelling persists, seek medical attention
Unconsciousness	Never attempt to give anything by mouth Keep victim flat, maintain an open airway If victim is not breathing, provide artificial respiration by mouth to mouth breathing and call for an ambulance immediately

9.2.4 Injury Due to Heat

If a person is suffering from heat exhaustion (profuse perspiration, normal body temperature), the following procedures will be taken

- Remove the person to a cooler, shaded area
- Give 8 ounces of Gatorade every 15 minutes for three or four doses
- Allow the person to rest
- If the person is suffering from cramps, press warm, wet towels over the cramped area

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	74 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

If a person is suffering from heat stroke (skin hot and dry, very high body temperature), the following procedures will be taken

- Decontaminate the victim
- Cool the victim quickly by soaking the person in cool but not cold water, sponging the body with rubbing alcohol or cool water, or pouring water on the body
- Reduce the body temperature to a safe level (about 102 to 105°F)
- Observe the victim for 10 minutes, if the body temperature starts to rise again, cool the victim again
- Transport to hospital for medical attention as soon as possible

9.2.5 Fire/Explosion

In the event of a fire or explosion, the Rocky Flats fire department should be summoned immediately. Upon their arrival, the PM or designated alternate will advise the fire commander of the location, nature, and identification of the hazardous materials on-site.

If it is safe to do so, site personnel may remove or isolate flammable or other hazardous materials which may contribute to the fire. Otherwise, immediate evacuation of the area is indicated.

Fire extinguishers are provided onsite for use by trained personnel only.

In the event of an explosion, all personnel shall be evacuated and the fire department notified. No one shall re-enter the area until it has been cleared by explosives safety personnel.

Rocky Flats Environmental Technology Site	Document No	RF/ER-95-0011
OU-2 Trenches and Mound Site	Section No	
Characterization Site Health and Safety Plan	Page	75 of 80
	Effective Date	
	Organization	Environmental Restoration Program Div

9.2.6 Natural Disasters

Natural disasters may occur at the site due to weather. These include lightning and high winds.

- 1 **Lightning** - Persons should not work in open areas, near trees or other equipment outside during lightning storms. Stop work until the storm passes. If possible, clear the site until the storm passes.
- 2 **High Winds** - If high winds are forecast, the site should be cleared before the winds become hazardous. Workers should be instructed to go to an appropriate shelter. If winds are sustained at 35 miles per hour (mph), work will be stopped until the wind subsides, or until authorization from EG&G is given to resume field work.
- 3 If an evacuation is called, account for all persons before leaving the site.
- 4 Notify the PM of any work stoppage due to lightning and high winds.

9.3 EMERGENCY EQUIPMENT

This equipment will be stored at appropriate locations selected during site mobilization. Emergency response equipment shall be moved from one site to another based on changing locations of field activities in order to ensure that emergency equipment is available in the work area.

- **Fire Extinguishers** (10 lb A/B/C)
- **First Aid Kit** At least one industrial first aid kit will be provided and maintained fully stocked in the support zone.

Rocky Flats Environmental
Technology Site
OU-2 Trenches and Mound Site
Characterization Site Health and
Safety Plan

Document No
Section No
Page
Effective Date
Organization Environmental Restoration Program Div

RF/ER-95-0011

76 of 80

- Gatorade or the equivalent
- Extra full set of PPE
- Emergency eye wash stations
- Absorbent socks or other material for spills

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	77 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

FIGURE 9-1
EMERGENCY PHONE NUMBERS AND HOSPITAL ROUTES
 (This figure must be posted on site in a prominent location near a telephone.)

ALL EMERGENCIES: DIAL 2911

EMERGENCY PHONE NUMBERS:

Rocky Flats Medical Facility (Bldg 122) (For life threatening emergencies)	966-2911
Avista Hospital (off-site) (For all other medical emergencies)	673-1000
Fire Department	966-2911
Police Department	966-2911

EMERGENCY SERVICES:

Directions to the RFP Medical Facility

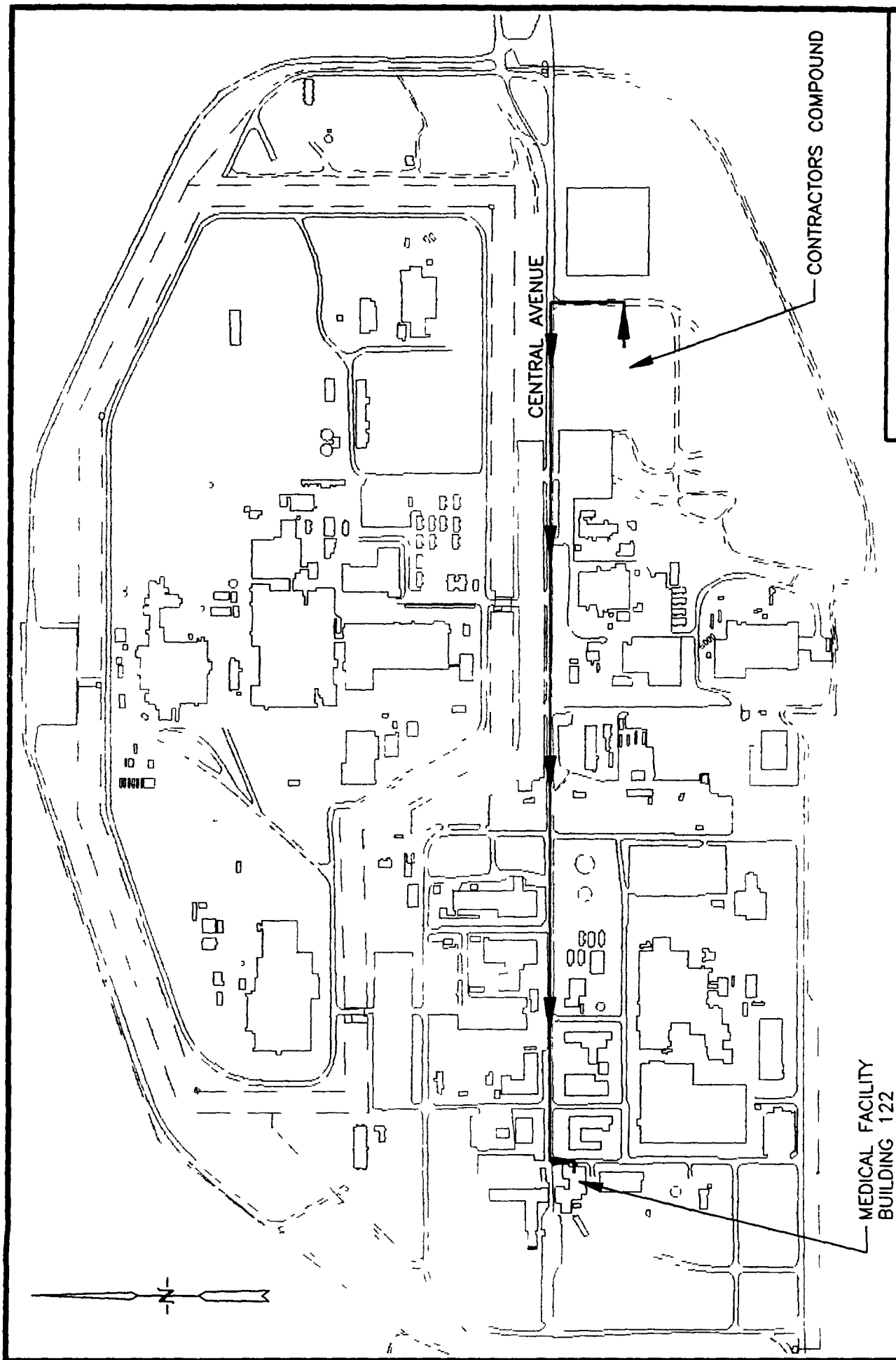
From the Contractor's compound, take a northbound street to Central Avenue and turn left (west) onto Central Avenue. Continue for approximately 1.25 miles. Building 122 will be on the left (south) side of the guard building to the right. See map, Figure 9-2.

Directions to Avista Hospital

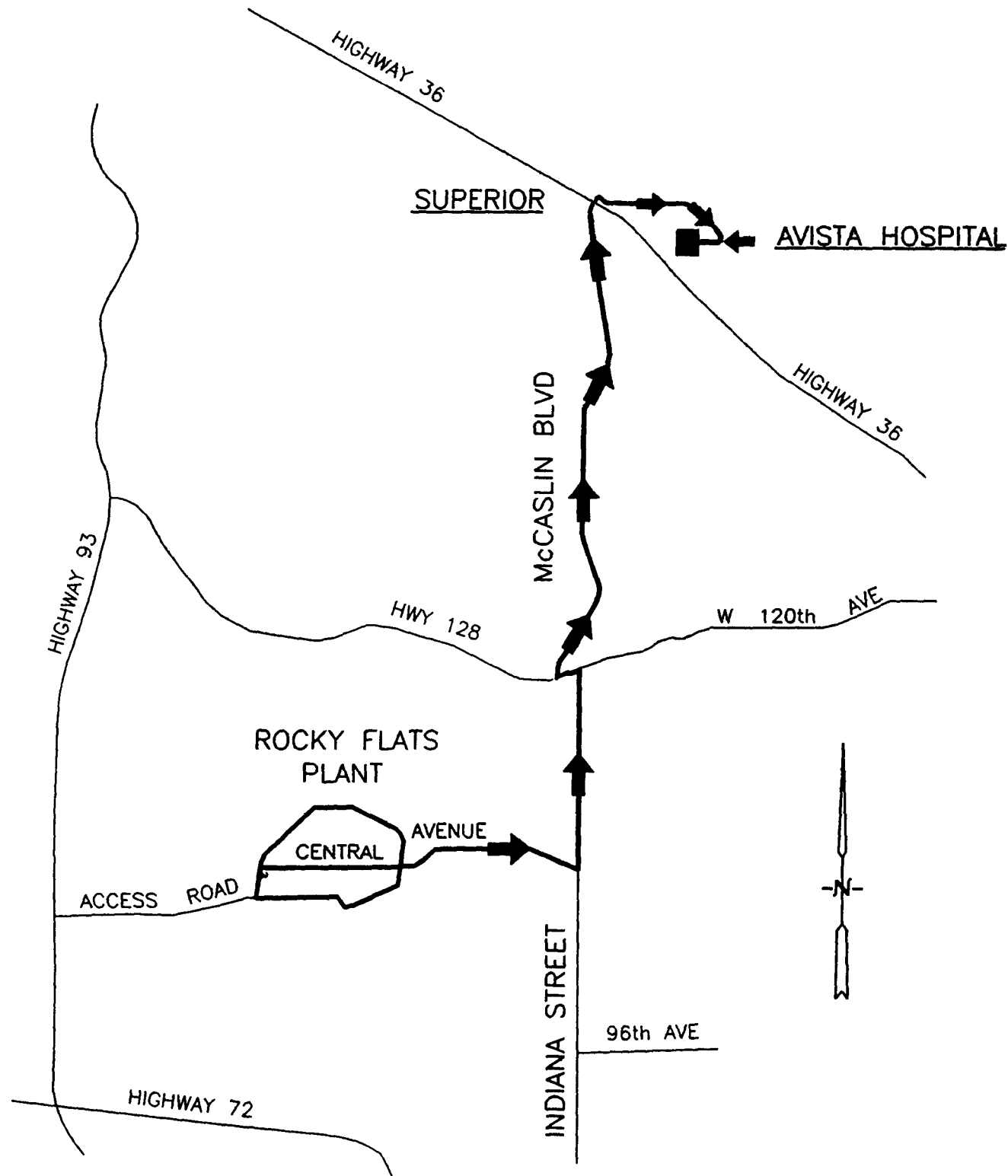
From the Contractor's compound, go north to Central Avenue and turn right (east) onto Central Avenue. Continue east to the east entrance to the plantsite, turn left (north) onto Indiana Street. At the intersection of Indiana Street and Highway 128, turn left (west). Continue west on Highway 128 to the intersection of McCaslin Boulevard. Turn right (north) onto McCaslin Boulevard. Continue north on McCaslin past the intersection with Highway 36 to Dillon Road. Turn right (east) on Dillon Road and continue to South 88th Street, then turn right (south). Turn right (west) on Health Park Drive and continue until it ends. The hospital is located at 100 Health Park Drive. See map, Figure 9-3.

W-C CONTACTS

Elaine Reilly (Project Manager)	(303) 740-3831
Karen Scudder, CIH (Corporate Health and Safety Officer)	(303)-740-3837
Kathleen Fischer (Health and Safety Officer)	(303) 796-4616



ROUTE TO RFETS
MEDICAL FACILITY (BLDG 122)
Figure 9-2



ROUTE TO AVISTA HOSPITAL

Figure 9-3

Rocky Flats Environmental	Document No	RF/ER-95-0011
Technology Site	Section No	
OU-2 Trenches and Mound Site	Page	80 of 80
Characterization Site Health and	Effective Date	
Safety Plan	Organization	Environmental Restoration Program Div

10.0 REFERENCES

U S Department of Energy (DOE) 1993 Preliminary Draft Phase II OU-2 RFI/RI Report,
903 Pad Mound and East Trenches Area Operable Unit No 2, Rocky Flats Plant,
Golden, Colorado December

APPENDIX A
COMPLIANCE AGREEMENT

SAFETY COMPLIANCE AGREEMENT AND DOCUMENTATION OF SITE SAFETY BRIEFING

DATE _____

TIME _____

SITE LOCATION _____

PROJECT NUMBER _____

SITE SAFETY OFFICER _____

TOPICS COVERED DURING BRIEFING

- | | |
|--|--|
| <p>_____ EXTENT AND CONCENTRATION OF CHEMICAL HAZARDS ON SITE</p> <p>_____ HEALTH EFFECTS OF CHEMICAL HAZARDS</p> <p>_____ PHYSICAL HAZARDS ON SITE</p> <p>_____ LEVELS OF PROTECTION REQUIRED</p> <p>_____ ROUTE TO THE HOSPITAL</p> <p>_____ LOCATION OF EMERGENCY EQUIPMENT (FIRST AID KIT FIRE FIGHTING EQUIPMENT)</p> <p>_____ VERIFICATION THAT HEALTH AND SAFETY PLAN HAS BEEN RECEIVED AND READ</p> | <p>_____ MONITORING PROCEDURES</p> <p>_____ ACTION LEVELS</p> <p>_____ DECONTAMINATION PROCEDURES</p> <p>_____ LOCATION OF EMERGENCY NUMBERS</p> |
|--|--|

I, the undersigned, have received a copy of the safety plan for the referenced project. I have read the plan, understand it and agree to comply with all of the health and safety requirements. I understand that I may be prohibited from working on the project for violating any of the requirements. In addition, I have been verbally briefed on the topics noted above.

DOCUMENTATION (SSO MUST SEE
VERIFICATION BEFORE INITIALING COLUMN)

ATTENDEES NAME	COMPANY	40 HR	FTT	MEDICAL
1 (print) _____ (signature) _____				
2 (print) _____ (signature) _____				
3 (print) _____ (signature) _____				
4 (print) _____ (signature) _____				
5 (print) _____ (signature) _____				
6 (print) _____ (signature) _____				

I, the undersigned, have received a copy of the safety plan for the referenced project I have read the plan, understand it, and agree to comply with all of the health and safety requirements I understand that I may be prohibited from working on the project for violating any of the requirements In addition, I have been verbally briefed on the topics noted above

DOCUMENTATION (SSO MUST SEE
VERIFICATION BEFORE INITIALING COLUMN)

ATTENDEES				
NAME	COMPANY	40 HR	FIT	MEDICAL
7 (print) _____ (signature) _____				
8 (print) _____ (signature) _____				
9 (print) _____ (signature) _____				
10 (print) _____ (signature) _____				
11 (print) _____ (signature) _____				
12 (print) _____ (signature) _____				

APPENDIX B
MATERIAL SAFETY DATA SHEETS



Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection

Sheet No. 296
Arsenic and Compounds

Issued 4/90

Section 1. Material Identification

31

Arsenic Description Obtained from flue dust of copper and lead smelters as white arsenic (arsenic trioxide) Reduction with charcoal and sublimation in an N_2 current yields pure arsenic. Metallic arsenic is used for hardening copper, lead, and alloys, as a doping agent in germanium and silicon solid-state products, special solders, and medicine, and to make gallium arsenide for diodes and other electronic devices. Arsenic compounds are used in manufacturing certain types of glass, in textile printing, tanning, taxidermy, pharmaceuticals, insecticides and fungicides, pigment production, and antifouling paints, and to control sludge formation in lubricating oils. Arsenic trioxide is the source for 97% of all arsenic products.

R 1
I 4
S 2
K 0



HMIS
H 3
F 2
R 2
PPG*
* Sec 8

Other Designations CAS No. 7440-38-2, arsen, arsenic black, As, gray arsenic, metallic arsenic

Manufacturer Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers Guide*⁽⁷⁾ for a suppliers list.

Section 2. Ingredients and Occupational Exposure Limits

Arsenic and soluble compounds, as As

OSHA PEL

8-hr TWA 0.5 mg/m³,* 0.01 mg/m³†

NIOSH REL, 1987

Ceiling 0.002 mg/m³

Toxicity Data†

Man, oral, TD_{Lo} 76 mg/kg administered intermittently over a 12-year period affects the liver (tumors) and blood (hemorrhage)

Man, oral 7857 mg/kg administered over 55 years produces gastrointestinal (in the structure or function of the esophagus), blood (hemorrhage), and skin and appendage (dermatitis) changes

Rat, oral, TC_{Lo} 605 µg/kg administered to a 35-week pregnant rat affects fertility (pre- and post-implantation mortality)

ACGIH TLV, 1989-90

TLV-TWA 0.2 mg/m³

* Organic compounds.

† Inorganic compounds

‡ See NIOSH, *RTECS* (CG0525000), for additional mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data*

Boiling Point sublimates at 1134 °F/612 °C

Atomic Weight 74.92

Melting Point 1497 °F/814 °C

Density 5.724 at 57 °F/14 °C

Vapor Pressure 1 mm at 702 °F/372 °C (sublimes)

Water Solubility Insoluble†

Appearance and Odor A brittle, crystalline, silvery to black metalloid. Odorless

* This data pertains to arsenic only

† Arsenic is soluble in nitric acid (HNO_3)

Section 4. Fire and Explosion Data

Flash Point None reported

Autoignition Temperature None reported

LEL None reported

UEL None reported

Extinguishing Media Use dry chemical, CO_2 , water spray, or foam to fight fires

Unusual Fire or Explosion Hazards Flammable and slightly explosive in the form of dust when exposed to heat or flame

Special Fire-fighting Procedures Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways

Section 5. Reactivity Data

Stability/Polymerization Arsenic is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur

Chemical Incompatibilities Arsenic can react vigorously on contact with powerful oxidizers such as bromates, peroxides, chlorates, iodates, lithium, silver nitrate, potassium nitrate, potassium permanganate, and chromium (VI) oxide. This material is also incompatible with halogens, bromine azide, palladium, dirubidium acetylide, zinc, and platinum

Hazardous Products of Decomposition Thermal oxidative decomposition of arsenic and its compounds produces irritating or poisonous gases

Section 6. Health Hazard Data

Carcinogenicity The IARC, NTP, and OSHA list arsenic as a human carcinogen (Group 1) This evaluation applies to arsenic and arsenic compounds as a whole, and not necessarily to all individual chemicals within the group Studies report that both the trivalent and pentavalent compounds are strongly implicated as causes of skin, lung, and lymphatic cancers Experimental studies have shown that arsenic has tumorigenic and teratogenic effects in laboratory animals

Summary of Risks Arsenic compounds are irritants of the skin, mucous membranes, and eyes The moist mucous membranes are most sensitive to irritation Prolonged contact results in local hyperemia (blood congestion) and later vesicular or pustular eruption Epidermal carcinoma is a reported risk of exposure Peripheral neuropathy (degenerative state of the nervous system) is common after acute or chronic arsenic poisoning Symptoms include decreased sensation to touch, pinprick, and temperature, loss of vibration sense, and profound muscle weakness and wasting Other complications of acute and chronic arsenic poisoning are encephalopathy (alterations of brain structure) and toxic delirium

Medical Conditions Aggravated by Long-Term Exposure Damage to the liver, nervous, and hematopoietic (responsible for the formation of blood or blood cells in the body) system may be permanent Pulmonary and lymphatic cancer may also occur

Target Organs Liver, kidneys, skin, lungs, lymphatic system.

Primary Entry Routes Inhalation, ingestion of dust and fumes, via skin absorption

Acute Effects. Acute industrial intoxication is more likely to arise from inhalation of arsine However, with corrosive arsenical vapors, conjunctivitis, eyelid edema, and even corneal erosion may result Inhalation may result in nasal irritation with perforation of the septum, cough, chest pain, hoarseness, pharyngitis, and inflammation of the mouth If ingested, metallic or garlic taste, intense thirst, nausea, vomiting, abdominal pain, diarrhea, and cardiovascular arrhythmias (heartbeat irregularities) may occur Symptoms generally occur within 30 minutes, but may be delayed for several hours if ingested with food Acute poisoning may result in acute hemolysis (breakdown of red blood cells)

Chronic Effects Chronic symptoms include weight loss, hair loss, nausea, and diarrhea alternating with constipation, palmar and plantar hyperkeratoses (thickening of the corneous layer of skin on palms and soles of feet), and skin eruptions, and peripheral neuritis (inflammation of the nerves) Leukemia, bone marrow depression, or aplastic anemia (dysfunctioning of blood-forming organs) may occur after chronic exposure

FIRST AID

Eyes Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min

Skin Quickly remove contaminated clothing After rinsing affected skin with flooding amounts of water, wash it with soap and water

Inhalation Remove exposed person to fresh air and support breathing as needed

Ingestion Never give anything by mouth to an unconscious or convulsing person If ingested, have a conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear

After first aid, get appropriate in-plant, paramedic, or community medical support.

Physician's Note If emesis is unsuccessful after two doses of ipecac, consider gastric lavage Monitor urine arsenic level Alkalinization of urine may help prevent disposition of red cell breakdown products in renal tubular cells If acute exposure is significant, maintain high urine output and monitor volume status, preferably with central venous pressure line Abdominal X-rays should be done routinely for all ingestions Chelation therapy with BAL, followed by n-penicillamine is recommended, but specific dosing guidelines are not clearly established

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak Notify safety personnel of spill, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide adequate ventilation Cleanup personnel should protect against dust inhalation and contact with skin and eyes Use nonsparking tools With a clean shovel, scoop material into a clean, dry container and cover Absorb liquid material with sand or noncombustible inert material and place in disposal containers Do not release to sewers, drains, or waterways Follow applicable OSHA regulations (29 CFR 1910.120)

Disposal Contact your supplier or a licensed contractor for detailed recommendations Follow applicable Federal, state, and local regulations

EPA Designations*

RCRA Hazardous Waste (40 CFR 261.33) Not listed

Listed as a CERCLA Hazardous Substance† (40 CFR 302.4), Reportable Quantity

(RQ) 1 lb (0.454 kg) [† per Clean Water Act, Sec 307(a), per Clean Air Act, Sec 112]

SARA Extremely Hazardous Substance (40 CFR 355) Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations†

Air Contaminant (29 CFR 1910.1000, Subpart Z) Not listed

* Designations for arsenic only

† Listed as arsenic organic compounds (as As)

Section 8. Special Protection Data

Goggles Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133)

Respirator Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA

Warning Air-purifying respirators do not protect workers in oxygen-deficient atmospheres

Other Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PELs, ACGIH TLVs, and NIOSH REL (Sec 2) Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source⁽¹⁰⁾

Safety Stations Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities

Contaminated Equipment Never wear contact lenses in the work area. soft lenses may absorb, and all lenses concentrate, irritants Remove this material from your shoes and equipment. Launder contaminated clothing before wearing

Comments Never eat, drink, or smoke in work areas Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics

Section 9. Special Precautions and Comments

Storage Requirements Store in closed, properly labeled, containers in a cool, well-ventilated area away from all incompatible materials (Sec 5) and heat and ignition sources Protect containers from physical damage

Engineering Controls Avoid inhalation or ingestion of dust and fumes, and skin or eye contact. Practice good personal hygiene and housekeeping procedures Use only with adequate ventilation and appropriate personal protective gear Institute a respiratory protection program with training, maintenance, inspection, and evaluation All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded Provide preplacement and annual physical examination with emphasis on the skin, respiratory system, and blood

Transportation Data (49 CFR 172.101, 102)

DOT Shipping Name Arsenic, solid

IMO Shipping Name Arsenic, metallic

DOT Hazard Class Poison B

IMO Hazard Class. 6.1

ID No UN1558

IMO Label Poison

DOT Label Poison

IMDG Packaging Group II

DOT Packaging Requirements 173.366

ID No UN1558

DOT Packaging Exceptions 173.364

MSDS Collection References 7, 26, 38, 53, 73, 85, 87, 88, 89, 100, 103, 109, 123, 124, 126, 127, 130, 136, 138

Prepared by. MJ Allison, BS, Industrial Hygiene Review DJ Wilson, CIH, Medical Review MJ Hardies, MD

M4

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Material Safety Data Sheets Collection

Sheet No. 297
Barium and Compounds

Issued 4/90

Section 1. Material Identification

31

Barium and Compounds Description Produced by reducing barium oxide with aluminum or silicon in a vacuum at high temperature. The minerals barite (BaSO_4) and witherite (BaCO_3) are the primary sources of barium. Used as lubricant for anode rotors in X-ray tubes, a deoxidizer for copper, an extender in paints, a loader for paper, soap, rubber, and linoleum, a carrier for radium, a fire extinguisher for uranium or plutonium fires, a rodenticide, a stabilizer and mold lubricant in the rubber and plastics industries, a flux for magnesium alloys, getter alloys in vacuum tubes, and in spark-plug alloys and Frary's metal. Important barium compounds include carbonate (ceramics, rodenticide), sulfate (pigment and filler), hydroxide (water treatment, ceramics), nitrate (pyrotechnics), chloride (chemicals), chromate (pigments), oxide (lubricants), and peroxide (bleach).

Other Designations CAS No. 7440-39-3, Ba.

Manufacturer Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers Guide*^(TM) for a suppliers list.

R 2
I 3
S 2
K 4

Genium



HMIS

H 2

F 2

R 4

PPG*

* Sec 8

Section 2. Ingredients and Occupational Exposure Limits

Barium, ca 100%

OSHA PEL

8-hr TWA 0.5 mg/m³ (Barium, soluble compounds, as Ba)

NIOSH REL, 1987

None established

Toxicity Data*

None listed

ACGIH TLV, 1989-90

TLV-TWA 0.5 mg/m³ (Barium, soluble compounds, as Ba)

* Monitor RTECS (CQ8370000), for additional future data.

Section 3. Physical Data*

Boiling Point 2984 °F/1640 °C

Molecular Weight 137.33 g/mol

Melting Point 1337 °F/725 °C

Specific Gravity ($\text{H}_2\text{O} = 1$ at 39 °F/4 °C) 3.51 at 68 °F/20 °C

Vapor Pressure 10 mm Hg at 1920 °F/1049 °C

Water Solubility Insoluble

Appearance and Odor A silver white metal that is slightly lustrous and somewhat malleable.

Comment Barium has a distinctive property of absorbing gases.

* Physical data are for barium only.

Section 4. Fire and Explosion Data

Flash Point None reported

Autoignition Temperature None reported

LEL None reported

UEL None reported

Extinguishing Media Do not use water or foam. For small fires, use dry chemical, soda ash, lime, or sand. For large fires, withdraw from area and let fire burn.

Unusual Fire or Explosion Hazards In the powder form, barium is flammable at room temperature. It is also explosive in the form of dust when exposed to heat, flame, or by chemical reaction. The chlorate, peroxide, and nitrate compounds are reactive and may present fire hazards in storage and use.

Special Fire-fighting Procedures Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and fully encapsulating suit. Barium may ignite itself if exposed to air. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization Barium is stable at room temperature under special storage and handling conditions (Sec. 9). If the free metal is exposed to air, an explosion hazard exists because hydrogen is liberated. Barium compounds are more stable than elemental barium. Hazardous polymerization cannot occur.

Chemical Incompatibilities. Barium reacts violently with water, carbon tetrachloride, trichloroethylene, fluorotrichloromethane, and tetrachloroethylene. This material is incompatible with acids, trichloroethylene and water, trichlorotrifluoroethane, 1,1,2-trichlorotrifluoroethane, and fluorotrichloroethane. Barium is extremely reactive and reacts readily with halogens and ammonia. Barium compounds are not as reactive as elemental barium. See MSDSs 40, 119, 132, 173, 181, and 251 for specific chemical incompatibilities.

Conditions to Avoid Avoid heating barium in hydrogen to about 392 °F/200 °C since it reacts violently and forms barium hydride (BaH_2). An explosion hazard exists if the free metal is exposed to moist air or cold water because hydrogen is liberated.

Section 6. Health Hazard Data

Carcinogenicity Although the NTP, IARC, and OSHA do not list barium as a carcinogen, the IARC lists barium chromate (VI) as a carcinogen.

Summary of Risks Barium presents mainly an explosion hazard. However, soluble compounds of barium by the oral route are highly toxic and the fatal dose of the chloride has been stated to be 0.8 to 0.9 g. Death may occur from a few hours to a few days. The soluble barium compounds exert a profound effect on skeletal, arterial, intestinal, bronchial, and particularly cardiac muscle. Effects on the hematopoietic system (responsible for the formation of blood or blood cells in the living body) and the cerebral cortex are also noted. Poisoning may also occur if the dust of soluble compounds is inhaled. Certain compounds of barium are irritants of the skin, eyes, and mucous membranes. Barium oxide and barium hydroxide, strongly alkaline in aqueous solution, cause severe skin irritation and burns of the eye. Inhalation of insoluble barium produces a benign pneumoconiosis (baritosis). The half-life of barium in bone has been estimated at 50 days.

Medical Conditions Aggravated by Long-Term Exposure None reported.

Target Organs Skin, eyes, mucous membranes, lung, heart.

Primary Entry Routes Inhalation of dust or fume, ingestion, skin or eye contact.

Acute Effects Systemic absorption from ingestion causes gastroenteritis (inflammation of the stomach lining and the intestines), slow pulse rate (heart may stop while contracting), muscle spasm, and hypokalemia (potassium deficiency in the blood). Inhalation causes coughing, bronchial irritation, and pneumoconiosis. Contact with soluble salts causes dermatitis, irritation of the eyes and mucous membranes, and burns. During radiological examination, intraperitoneal (in the abdomen) or intrathoracic (in the chest) barium sulfate contamination resulting from a complication rupture may cause a significant inflammatory response.

Chronic Effects Although baritosis (caused by inhaling barium sulfate) produces nodular opacities on chest X-rays, there is no evidence of clinical illness or bodily dysfunction.

FIRST AID

Eyes Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin Quickly remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.

Inhalation Remove exposed person to fresh air and support breathing as needed.

Ingestion Never give anything by mouth to an unconscious or convulsing person. If ingested, have a conscious person drink 1 to 2 glasses of water, then induce vomiting.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Physician's Note Consider using calcium gluconate for muscular spasms. Consider gastric lavage followed by saline catharsis if soluble barium compounds are ingested. Institute cardiac monitoring for all significant ingestions of soluble barium salts.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak Notify safety personnel of spill. Immediately shut off all heat and ignition sources and evacuate hazard area. Cleanup personnel should protect against dust inhalation and contact with skin, eyes, and mucous membranes. For small dry spills, use a clean shovel to place material into a clean, dry container with a cover. For a large dry spill, cover with a plastic sheet to minimize spreading. For liquid spills, cover with sand or other noncombustible material and place in disposal containers. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations*

RCRA Hazardous Waste (40 CFR 261.33) Not listed

CERCLA Hazardous Substance (40 CFR 302.4) Not listed

SARA Extremely Hazardous Substance (40 CFR 355) Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations*

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

*Designations for barium only

Section 8. Special Protection Data

Goggles Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

Warning Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Other Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below OSHA PEL and ACGIH TLV (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰⁾

Safety Stations Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements Store under inert gas, petroleum, or oxygen-free liquid in a cool, dry, well-ventilated area away from all incompatibles (Sec. 5).

Engineering Controls Barium metal itself presents mainly an explosion hazard. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Use nonsparking tools. Proper storage is essential. Avoid dust inhalation and skin, eye, and mucous membrane contact. All processes should be enclosed and/or exhaust ventilation installed to keep the dust concentrations below the recommended levels. Practice good personal hygiene and housekeeping procedures. Preemployment and periodic medical examinations should be given to workers exposed to barite dust. Prevent exposing individuals with respiratory disorders.

Transportation Data (49 CFR 172.102)

IMO Shipping Name Barium alloys, pyrophoric

IMO Hazard Class 4.2

IMO Label Spontaneously combustible

MDG Packaging Group II

ID No. UN1854

MSDS Collection References 7, 26, 38, 73, 85, 87, 89, 100, 103, 109, 123, 124, 126, 127, 133, 136, 138, 139

Prepared by MJ Allison, BS, Industrial Hygiene Review DJ Wilson, CIH, Medical Review W Silverman, MD

F4

Material Safety Data Sheet

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No 23

CADMIUM

(Revision C)

Issued September 1977

Revised November 1988

SECTION 1. MATERIAL IDENTIFICATION

27

Material Name CADMIUM**Description (Origin/Uses)** Used in electroplating other metals, in dentistry, in alloys, in nickel-cadmium batteries, and in reactor control rods**Other Designations** Cd, CAS No 7440-43-9**Manufacturer** Contact your supplier or distributor Consult the latest edition of the *Chemicalweek Buyers Guide* (Genium ref 73) for a list of suppliers

Genium

HMS

H 3 R 1

F 1 I 4

R 0 S 1

PPG*

*See sect 8 K 4 (Dust)

SECTION 2. INGREDIENTS AND HAZARDS, EXPOSURE LIMITS**Cadmium**, CAS No 7440-43-9, ca 100%**OSHA PEL**8-Hr TWA 0.1 mg/m³ (Cd Fume)Ceiling 0.3 mg/m³ (Cd Fume)8-Hr TWA 0.2 mg/m³ (Cd Dust)Ceiling 0.6 mg/m³ (Cd Dust)**ACGIH NIC,* 1988-89**TLV-TWA 0.01 mg/m³ (Cadmium and Compounds, as Cd)

ACGIH A2, Suspected Human Carcinogen

ACGIH TLVs, 1988-89TLV-TWA 0.05 mg/m³ (Cadmium Dusts and Salts, as Cd)TLV-Ceiling 0.05 mg/m³ (Cadmium Oxide Fume, as Cd)TLV-TWA 0.05 mg/m³ (Cadmium Oxide Production)**Toxicity Data****Human, Inhalation, LC₅₀ 39 mg/m³ (20 Minutes)

*Notice of Intended Changes, Genium reference 116, p 39

**See NIOSH, RTECS (EU9800000), for additional data referring to reproductive, tumorigenic, and mutagenic effects

SECTION 3. PHYSICAL DATA**Boiling Point** 1413°F (767°C)**Melting Point** 610°F (321°C)**Vapor Pressure** 0.095 Torr at 610°F (321°C)**Molecular Weight** 112 Grams/Mole**Solubility in Water (%)** Insoluble**Specific Gravity (H₂O = 1)** 8.642**Appearance and Odor** A soft, blue white, malleable, lustrous metal that can be cut easily with a knife, odorless**Comments.** Cadmium has a significant vapor pressure of 0.000021 torr (corresponding to 0.12 mg/m³) at 315°F (157°C). Heating this metal without using correct engineering controls and/or personal protective equipment can result in overexposure.**SECTION 4. FIRE AND EXPLOSION DATA****Flash Point and Method*****Autoignition Temperature*****LEL*****UEL***

Extinguishing Media *Cadmium metal burns readily in air if it is heated. As with most metals, the reactivity/dust-cloud-explosion hazard increases as the cadmium metal becomes more finely divided. In fact, finely divided, powdered cadmium metal can be pyrophoric (it burns spontaneously in air without any source of ignition). Carbon dioxide, dry chemical, or sand are recommended extinguishing agents for cadmium fires. **Unusual Fire or Explosion Hazards** Cadmium dust can explode during a fire. Massive cadmium metal does not present this potential explosion hazard, however, certain work operations such as grinding, welding, or cutting, can produce dust made of finely divided cadmium particles. **Warning** Do not create a dust cloud of cadmium particles, especially during cutting, grinding, or welding operations. **Special Fire-fighting Procedures** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA**Stability/Polymerization** Cadmium is stable in closed containers during routine operations. Hazardous polymerization cannot occur.**Chemical Incompatibilities** Cadmium reacts dangerously with ammonium nitrate, hydrazoic acid, tellurium, and zinc (Genium ref 84).**Conditions to Avoid** Avoid all exposure to sources of ignition and to incompatible chemicals. **Hazardous Products of Decomposition** When heated, which is likely during fires and work operations such as welding and machining, cadmium metal can decompose into cadmium metal fume and cadmium oxide fume.**SECTION 6. HEALTH HAZARD INFORMATION**

Carcinogenicity The ACGIH classifies cadmium and its compounds as suspected human carcinogens (group A2), the IARC lists them as probable human carcinogens (group 2B), and the NTP classifies them as anticipated human carcinogens (group b). **Summary of Risks.** Heating cadmium metal produces intensely irritating cadmium metal fume. The acute effects of its excessive inhalation, which include severe tracheobronchitis, pneumonitis, and pulmonary edema, are life threatening and are usually delayed for several hours, their mortality rate is about 20%. Nonfatal pneumonitis has resulted from exposure to 0.5 to 2.5 mg/m³, a fatality has been reported for five hours' exposure at 9 mg/m³ and for 1 hour's exposure at 40 to 50 mg/m³. There is no warning discomfort or immediate irritation from exposure to cadmium fume. Acute gastroenteritis and symptoms of metal fume fever are associated with even lower acute exposure. Symptoms of acute overexposure include excessive salivation, a dry, burning throat, headache, aching muscles, coughing, chest tightness and pain, nausea, chills, and fever chills, and fever. **Medical Conditions Aggravated by Long-Term Exposure** None reported. **Target Organs** Skin, eyes, respiratory system, kidneys, and blood. **Primary Entry** Inhalation, skin contact. **Acute Effects** See Summary of Risks, above. **Chronic Effects** Long-term, chronic inhalation of cadmium dust, salts, or fume causes chronic cadmium poisoning characterized by a distinctive, nonhypertrophic emphysema with or without renal tubular injury, accompanied by the urinary excretion of a protein with a molecular weight

SECTION 6. HEALTH HAZARD INFORMATION, cont.

of 20,000 to 30,000 This protein is itself a sign of early but reversible chronic poisoning (Possible chromosomal aberrations and decreased birth weight among babies of women exposed to cadmium have been noted.) **Danger** Continued overexposure from inhalation causes irreversible renal tubular damage Cancer, anemia, eosinophilia, anosmia, chronic rhinitis, yellowed teeth, and bone changes have been reported Bone pain in the ribs, backbone, and femur is common, disorders of calcium metabolism develop, and kidney stones and pulmonary fibrosis have been described **FIRST AID** Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes Skin Rinse the affected area with flooding amounts of water, then wash it with soap and water **Inhalation** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed Have qualified medical personnel administer oxygen as required **Ingestion** If a physician is not readily available, give the exposed person 2 to 3 glasses of water to drink and induce vomiting A physician may administer a gastric lavage followed by saline catharsis **Comments** A comprehensive medical program is advised for those who work with cadmium or its compounds This should include chest X rays and forced-vital-capacity tests Get medical help (in plant, paramedic, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid **Note to Physician** Chelation therapy may be useful in treatment, calcium disodium edetate and penicillamine are recommended Dimercaprol (BAL) is not recommended because of reported renal toxicity of the cadmium-BAL complex

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate ventilation Cleanup procedures must not create dusty conditions Pick up the spilled material using vacuuming, mopping, or wet-sweeping techniques Cleanup personnel need protection against inhalation of dust and fume (see sect. 8) **Waste Disposal** Contact your supplier or a licensed contractor for detailed recommendations Follow Federal, state, and local regulations Concentrated solutions of cadmium waste can be precipitated with lime and collected by filtration Effluent should be treated as needed to reduce the concentration of the cadmium to a level that is within regulatory compliance limits

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910 1000 Subpart Z)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste, No D006 (40 CFR 261 24 [Characteristic of EP toxicity])

CERCLA Hazardous Substance, Reportable Quantity 1 lb (0 454 kg), per the Clean Water Act (CWA), § 307 (a)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles Always wear protective eyeglasses or chemical safety goggles Where splashing of a cadmium solution is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910 133) **Respirator** Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2 Follow OSHA respirator regulations (29 CFR 1910 134) For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA **Warning** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres Other Wear impervious gloves, boots, aprons, and gauntlets, to prevent prolonged or repeated skin contact with this material. **Ventilation** Install and operate general and local maximum explosion-proof ventilation systems powerful enough to maintain airborne levels of cadmium below the OSHA PEL cited in section 2 Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source Consult the latest edition of Genium reference 103 for detailed recommendations **Safety Stations** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas **Contaminated Equipment** Contact lenses pose a special hazard, soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area Remove contaminated clothing and launder it before wearing it again, clean this material from your shoes and equipment. Do not wear work clothes home **Comments** Practice good personal hygiene, always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking Do *not* eat, drink, or smoke in any work area Do not inhale cadmium fume Do not expose individuals with lung, liver, kidney, and blood ailments to cadmium until such exposure is approved by a physician

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation Store cadmium in closed containers in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers Protect containers from physical damage Avoid storage situations where corrosion can occur Keep powdered cadmium in closed containers, prevent the airborne dispersion of powdered cadmium. **Engineering Controls** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design Ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, producing, and sampling operations to prevent static sparks **Other Precautions** The toxic effects of cadmium are influenced by the presence or absence of other elements such as zinc and selenium. If these materials are present in the workplace, careful evaluation of any exposure to cadmium is required to understand any contributing factors

Hazardous Materials Table (49 CFR 172 101) Not Listed

Optional Hazardous Materials Table (49 CFR 172 102)

ID No UN2570

IMO Shipping Name Cadmium Compounds

IMO Hazard Class 6 1

IMO Labels Poison or Saint Andrew's Cross (X)*

*Harmful—Stow away from Foodstuffs (IMO Label, Materials of Class 6 1 Packaging Group III)

References 1, 26, 38, 84-94, 100, 116, 117, 120, 122

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Material Safety Data Sheets Collection

Sheet No. 410
Carbon Tetrachloride

Issued 12/80

Revision B, 4/90

Section 1. Material Identification
31

Carbon Tetrachloride Description A chlorinated hydrocarbon derived from interacting carbon disulfide and chlorine in the presence of iron, or chlorination of methane or higher hydrocarbons at 482 °F/250 °C to 752 °F/400 °C. Carbon tetrachloride is treated with caustic alkali solution to remove sulfur chloride. Its primary use is in manufacturing fluoro-carbon propellants. It is also used in producing of semiconductors, chlorinating organic compounds, metal degreasing, refrigerants, as a solvent for oils, fats, resins, rubber waxes, lacquers, and varnishes, and as an agricultural fumigant. This material was widely used in the dry-cleaning industry.

Other Designations CAS No. 0056-23-5, CCl_4 , carbon chloride, carbon tet, methane tetrachloride, perchloromethane, tetrachlorocarbon, tetrachloromethane.

Manufacturer Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*⁽⁷⁾ for a suppliers list.

R 1
I 4
S 2*
K 0
*Skin
absorption



HMIS
H 3
F 0
R 0
PPG†
† Sec 8

Section 2. Ingredients and Occupational Exposure Limits

Carbon tetrachloride, ca 100%

OSHA PEL

8-hr TWA 2 ppm, 12.6 mg/m³

ACGIH TLV (Skin), 1989-90

TLV-TWA 5 ppm, 31 mg/m³

NIOSH REL, 1987

60-min ceiling 2 ppm, 12.6 mg/m³

Toxicity Data*

Rat, oral, LD₅₀ 2800 mg/kg, toxic effects not yet reviewed

Rat, inhalation, LC₅₀ 8000 ppm over 4 hr, no toxic effect noted

Human, inhalation, TC_{Lo} 20 ppm inhaled produces gastrointestinal effects (nausea or vomiting)

* See NIOSH, RTECS (FG4900000), for additional irritative, mutative, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point 169.77 °F/76.54 °C

Melting Point -9.4 °F/-23 °C

Vapor Pressure 91.3 mm Hg at 68 °F/20 °C

Vapor Density (Air = 1) 5.32

Molecular Weight 153.84 g/mol

Specific Gravity (H₂O = 1 at 39 °F/4 °C) 1.5940 at 68 °F/20 °C

Water Solubility Very slightly soluble (800 mg/l at 68 °F/20 °C)

Evaporation Rate (Butyl Acetate = 1) 12.8

Appearance and Odor A colorless liquid with a heavy ethereal odor. The high and low odor thresholds are, respectively, 128.4 and 60 mg/m³. Odor is not an adequate warning sign to prevent overexposure.

Section 4. Fire and Explosion Data

Flash Point None reported

Autoignition Temperature None reported

LEL None reported

UEL None reported

Extinguishing Media Carbon tetrachloride is nonflammable and will not support combustion. Use extinguishing media appropriate to the surrounding fire. This material was previously used as an extinguishing medium in portable fire extinguishers, but its toxicity and fire decomposition products lead to its replacement with "safer" extinguishing media.

Unusual Fire or Explosion Hazards Carbon tetrachloride can react violently with hot or burning metals such as aluminum and magnesium.

Special Fire-fighting Procedures Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and fully encapsulating suit. Use water spray to cool fire-exposed containers. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization Carbon tetrachloride is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities Carbon tetrachloride reacts violently with fluorine gas, alkali metals, and aluminum (see reference 126 for specific incompatibilities).

Conditions to Avoid This material has caused explosions when used as a fire extinguisher on wax fires and uranium fires. It may also form toxic phosgene when used to put out electrical fires.

Hazardous Products of Decomposition Thermal oxidative decomposition of carbon tetrachloride can produce toxic phosgene and hydrogen chloride.

Section 6. Health Hazard Data

Carcinogenicity The NTP, IARC, and ACGIH list carbon tetrachloride as an anticipated human carcinogen, a possible human carcinogen, and a suspected human carcinogen, respectively

Summary of Risks Carbon tetrachloride is highly toxic and irritating by inhalation, ingestion (mean lethal dose is 5 to 10 ml), and skin absorption. Alcohol's synergistic effects markedly increase CCl_4 's toxicity. Excessive exposure may result in central nervous system depression, cardiac arrhythmias, and gastrointestinal symptoms. In humans the majority of fatalities have been the result of renal injury with secondary cardiac failure. Kidney and liver damage can occur from severe acute or chronic exposure. Human liver damage occurs more often after ingestion of the liquid than after the inhalation of the vapor. However, after a 30 min to 1 hr exposure to concentrations of 1000 to 2000 ppm, humans have died from acute renal damage.

Medical Conditions Aggravated by Long-Term Exposure Prolonged recovery and permanent disability of the liver, kidney, and lungs are possible.

Target Organs Central nervous system, eyes, skin, liver, kidneys, lungs

Primary Entry Routes Inhalation, percutaneous (through the skin)

Acute Effects Acute exposure symptoms include eye, nose, skin, and throat irritation, cough, dyspnea, cyanosis, cardiac arrhythmias, headaches, dizziness, mental confusion, nausea, vomiting, abdominal pain, and diarrhea. Jaundice and abnormal liver enlargement accompanied by oliguria (reduced excretion of urine), proteinuria (protein in urine), and hematuria (blood in urine) may occur even after several days delay.

Chronic Effects Chronic exposure symptoms include defatting dermatitis, headaches, dizziness, mental confusion, apathy, anorexia, nausea, vomiting, abdominal pain, weight loss, narrowing of visual field, optic nerve damage with possible blindness, hearing loss, and renal and hepatic decompensation (loss of these organs' ability to correct dysfunction). Chronic exposure may result in the development of aplastic anemia.

FIRST AID

Eyes Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin Quickly remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.

Inhalation Remove exposed person to fresh air and support breathing as needed.

Ingestion Never give anything by mouth to an unconscious or convulsing person. Give one to two glasses of water to dilute and induce vomiting, unless the person shows evidence of decreasing mental functioning and awareness.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Physician's Note To minimize hepatorenal damage, consider intravenous acetylcysteine. Hyperbaric oxygen is also utilized for significant exposures. Dialysis has also been suggested in severe cases. Give cardiorespiratory support as indicated and carefully monitor fluid and electrolytes. Closely monitor hepatic and renal functions. Avoid epinephrine because of myocardial sensitization and potential for inducing ventricular arrhythmias.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak Notify safety personnel, evacuate area, and provide maximum exhaust ventilation. Cleanup personnel should protect against inhalation and skin and eye contact. Small spills can be absorbed on paper or some noncombustible, inert ingredient and allowed to evaporate in a hood. For large spills, dike far ahead to contain spill for disposal. Prevent release of CCl_4 to surface water or sewers. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-2)

SARA Extremely Hazardous Substance (40 CFR 355) Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ) 5000 lb (2270 kg) [* per RCRA, Sec. 3001, per Clean Water Act, Sec. 307(a), 311 (b)(4)]

Section 8. Special Protection Data

Goggles Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

Warning Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Other Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. Polyvinyl alcohol protective gear is recommended.

Ventilation Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL, ACGIH TLV, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾

Safety Stations Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment Never wear contact lenses in the work area. Soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements. Store in tightly closed container in a cool, dry, well-ventilated, low fire-risk area away from incompatible materials (Sec. 5), direct sunlight, and heat. Prevent exposure of vapors to high temperature to prevent decomposition to toxic and corrosive gases and vapors.

Engineering Controls Avoid vapor inhalation and skin or eye contact. Use only with adequate ventilation and appropriate personal protective gear. Monitor vapor levels and institute a respiratory protection program which includes training, maintenance, inspection, and evaluation.

Practice good personal hygiene procedures. When possible, substitute a less hazardous solvent for CCl_4 . Provide preplacement and biannual medical exams, including studies of liver and kidney function. Prevent exposing individuals with liver, kidney, or central nervous system diseases, or alcoholism. Alcohol's synergistic effects markedly increase CCl_4 's toxicity.

Transportation Data (49 CFR 172.101, 102)

DOT Shipping Name Carbon tetrachloride

IMO Shipping Name Carbon tetrachloride

DOT Hazard Class ORM-A

IMO Hazard Class 6.1

ID No.: UN1846

IMO Label Poison

DOT Label None

IMDG Packaging Group II

DOT Packaging Requirements 173.620

ID No. UN1846

DOT Packaging Exceptions 173.505

MSDS Collection References 7, 26, 38, 53, 73, 84, 85, 88, 89, 100, 103, 109, 124, 126, 127, 129, 130, 131, 134, 136, 137

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M5



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Material Safety Data Sheets Collection:

Sheet No. 315
Chloroform

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Revision D, 9/92

Section 1. Material Identification

Chloroform (CHCl₃) Description Derived by chlorination of methane, hydrochlorination of methanol, or reaction of chlorinated lime with acetone, acetaldehyde, or ethanol. Purified by extraction with concentrated sulfuric acid and rectification. Used in the manufacture of fluorocarbons (mainly FC-22) for refrigerants, in plastics, photographic processing, fire extinguishers, insecticides, and dry cleaning, as a solvent for fats, oils, waxes, rubbers, alkaloids, Gutta-Percha, and resins. Used as an anesthetic since 1847 but abandoned within the last few decades because of cardiac arrest during surgery and delayed death due to liver injury.

Other Designations CAS No. 67-66-3, Freon-20, methane trichloride, methenyl chloride, R-20 (refrigerant), trichloroform, trichloromethane, TCM. Improperly called 'formyl chloride.'

Manufacturer Contact your supplier or distributor. Consult latest *Chemical Week Buyers Guide*⁽⁷³⁾ for a suppliers list.

Cautions Chloroform is considered one of the most dangerous and volatile chlorinated hydrocarbons. It is a central nervous system (CNS) and cardiac depressant, an eye, skin, and respiratory tract irritant, and causes liver and kidney damage from acute and chronic exposure.

R 1	NFPA
I 3	
S 2*	
K 2	
* Skin absorption	
	HMIS
	H 3†
	F 0
	R 0
	PPE†
	† Chronic effects
	‡ Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Chloroform, ca 99% Usually contains 0.75% ethanol as a stabilizer. Impurities include bromodichloromethane, vinylidene, and diethyl carbonate.

1991 OSHA PEL
8-hr TWA. 2 ppm (9.78 mg/m³)

1992-93 ACGIH TLV
TWA. 10 ppm (49 mg/m³)

1985-86 Toxicity Data*

Human, inhalation, TC_{Lo} 10 mg/m³/1 year caused anorexia, nausea, and vomiting.

1990 IDLH Level
1000 ppm

1990 DFG (Germany) MAK
TWA. 10 ppm (50 mg/m³)

Rat, oral, TD_{Lo} 13832 mg/kg given continuously for 2 years caused leukemia.

1990 NIOSH REL
60 min STEL 2 ppm (9.78 mg/m³)

Category II. Substances with systemic effects. Half-life = 2 hr. Peak Exposure Limit. 20 ppm, 30 min average value, 4/shift.

Rat, oral, LD₅₀ 908 mg/kg caused weight loss or decreased weight gain. Rat, inhalation, TC_{Lo} 30 ppm/7 hr administered from the 6 to 15 day of pregnancy caused fetotoxicity or developmental abnormalities of the musculoskeletal system.

Rabbit, eye. 20 mg/24 hr caused moderate irritation.

* See NIOSH RTECS (FS9100000) for additional irritation, mutation, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point. 143 °F (62 °C)
Freezing Point. -82 °F (-63.5 °C)
Molecular Weight. 119.39
Viscosity. 5.63 mP at 68 °F (20 °C)
Relative Evaporation Rate (BuAc=1). 11.6
Surface Tension. 27.1 dyne/cm at 68 °F (20 °C)
Refraction Index. 1.4422 at 77 °F (25 °C)

Density. 1.49845 at 59 °F (15 °C)
Water Solubility. Nearly insoluble, 0.5% at 77 °F (25 °C)
Other Solubilities. Soluble in ethanol, ethyl ether, benzene, acetone, carbon disulfide, and carbon tetrachloride.
Odor Threshold. 85 to 307 ppm (range from combined sources)
Vapor Pressure. 160 mm Hg at 68 °F (20 °C), 200 mm Hg at 77 °F (25 °C)
Saturated Vapor Density (Air = 0.075 lb/ft³ or 1.2 kg/m³) 0.136 lb/ft³ or 2.183 kg/m³

Appearance and Odor. Colorless, volatile liquid with a heavy, ethereal odor.

Section 4. Fire and Explosion Data

Flash Point. Nonflammable Autoignition Temperature. Nonflammable LEL. None reported UEL. None reported

Extinguishing Media Nonflammable from standard tests in air but will burn on prolonged exposure to flame or high temperature. To fight fire, use extinguishing agents suitable for surrounding fire. Do not scatter material with a high-pressure water stream. **Unusual Fire or Explosion Hazards.** Container may explode in heat of fire. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing is not effective. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization Chloroform is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Its pH decreases on prolonged exposure to air and light due to hydrochloric acid (HCl) formation. The recommended shelf-life is 2 months for full containers and 2 weeks for partially full containers. **Chemical Incompatibilities:** Incompatible with acetone, alkalis, aluminum, disilane, lithium, magnesium, dinitrogen dioxide, nitrogen tetroxide, perchloric acid, phosphorus pentoxide, potassium, potassium hydroxide, methyl alcohol, potassium *tert*-butoxide, sodium, sodium hydroxide, sodium methylate, sodium-potassium alloy, triisopropylphosphine, calcium hydroxide, and fluorine and any strong oxidizers. **Conditions to Avoid** Exposure to light, prolonged heat, and incompatibles. **Hazardous Products of Decomposition** Thermal oxidative decomposition of CHCl₃ can produce carbon dioxide and toxic chlorine, HCl, and phosgene gas. CHCl₃ decomposes at 437 °F to formic acid, carbon monoxide, and HCl on prolonged heating with water.

Section 6. Health Hazard Data

Carcinogenicity Chloroform is considered a carcinogen by the IARC (Class-2B, possibly carcinogenic in humans with limited human and sufficient animal evidence),⁽¹⁶⁴⁾ NTP (Class 2, reasonably anticipated to be a carcinogen, limited human and sufficient animal evidence),⁽¹⁶⁹⁾ and NIOSH (Class X, carcinogen defined with no further categorization),⁽¹⁶⁴⁾ DFG (MAK-B, justifiably suspected of having carcinogenic potential),⁽¹⁶³⁾ and ACGIH (Class A2, suspected human carcinogen based on limited epidemiologic evidence or demonstration).⁽¹⁶³⁾ Carcinogenicity tends to be organ specific primarily to the liver and kidneys. **Summary of Risks** Chloroform is a CNS depressant, eye, skin, and respiratory tract irritant, and causes damage to the liver and kidneys. Symptoms range from dizziness to cardiac arrhythmias resulting in death. Chloroforms' toxicity is due to its easy lipid solubility. Avoid exposure during pregnancy because CHCl₃ diffuses readily across the placenta. Alcoholics seem to be affected sooner and more severely than others from chloroform exposure (alcohol may already have damaged the liver). Ethanol, polybrominated biphenols, steroids, and ketones potentiate chloroform's toxicity.

Continue on next page

No 315 Chloroform 9/92

Section 6. Health Hazard Data

Target Organs Liver, kidney, heart, eyes, skin. **Primary Entry Routes** Inhalation, ingestion, skin contact/absorption. **Medical Conditions Aggravated by Long Term Exposure** Alcoholism, liver, kidney, or nervous system disorders. **Acute Effects** Vapor inhalation causes varying degrees of CNS depression depending on concentration and exposure length. Symptoms include headache, nausea, dizziness, drunkenness, progressive weakness, vomiting, thirst, delirium, and disorientation. Exposure to 14,000 to 16,000 ppm has caused rapid unconsciousness. Severe acute exposures can damage the liver and kidney (damage is usually not observed for 24 to 48 hr post exposure), respiratory failure, severe cardiac arrhythmias (reason for discontinuation of use as an anesthetic), and death. Apparent recovery from heavy exposures may result in delayed death due to liver or kidney failure. Death usually occurs 4 to 5 days post exposure and autopsy shows massive liver necrosis. Vapors cause eye irritation and spasmodic winking. Direct eye contact with the liquid causes immediate burning pain and possible corneal epithelium damage. Skin contact with the liquid produces burning pain, erythema, and vesiculation due to defatting of the skin. Ingestion can cause gastrointestinal irritation, irregular heartbeat, nausea and vomiting, diarrhea (possibly blood-stained), drowsiness, unconsciousness, and state of shock. **Chronic Effects:** Prolonged inhalation of chloroform vapors causes fatigue, digestive disturbances, frequent and burning urination, mental dullness, and CNS and peripheral neuropathies. Liver (fatty degeneration and enlargement with hepatitis seen in dogs) and kidney damage may also occur.

FIRST AID **Eyes** Do not allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin** Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation.** Remove exposed person to fresh air and support breathing as needed. **Ingestion** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that conscious and alert person drink 1 to 2 glasses of water, to dilute. Do not induce vomiting because victim may become obtunded. Gastric lavage may be indicated if patient is comatose or at risk of convulsing. **Note to Physicians:** Because effects may be delayed (especially kidney and liver problems), keep victim under observation for 24 to 48 hr. Administration of fluids may help to prevent kidney failure. Obtain blood glucose, urinalysis, liver function tests, chest x-ray, and monitor cardiac function and fluid/electrolyte status. Monitor liver and kidney function for 4 to 5 days after exposure. Disulfiram, its metabolites, and a high carbohydrate diet appear to protect somewhat against chloroform toxicity. Do not give adrenalin! Tests may show increased bilirubin, ketosis, lowered blood prothrombin, and fibrogen.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. If possible without risk, move container from spill area. Cleanup personnel should wear fully encapsulating vapor-protective clothing. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for disposal. For large spills, dike far ahead of spill and contain for later disposal or reclamation. Spills in water may need to be trapped at the bottom with sand bag barriers and treated with activated carbon and removed by suction hoses, mechanical lifts, and dredges. Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values.** Rainbow Trout (*Salmo gairdneri*), $LC_{50} = 2030 \mu\text{g/L}$, bluegill (*Lepomis macrochirus*), $LC_{50} = 100,000 \mu\text{g/L/96 hr}$; largemouth bass (*Micropterus salmoides*) $LC_{50} = 51 \text{ ppm/96 hr}$. **Environmental Degradation** If released to land, most chloroform evaporates rapidly (due to high vapor pressure) while some may leach to groundwater where it remains for a long time on the bottom. If released to water, chloroform evaporates rapidly with estimated half-lives of 36 hr (river), 40 hr (pond), 9 to 10 days (lake). In air, chloroform photodegrades with a half-life of 80 days. It can be transported long distances and some may return to earth via rain. **Disposal** Reclamation is possible through distillation or steam stripping. Chloroform is a candidate for liquid incineration, rotary kiln, or fluidized bed incineration with an acid scrubber. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33) No. U044

Listed as a SARA Extremely Hazardous Substance (40 CFR 355), TPQ 10,000 lb

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4) Final Reportable Quantity (RQ), 10 lb (4.54 kg) [* per RCRA, Sec. 3001, CWA, Sec. 311(b)(4), & CWA Sec. 307(a)]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles Wear chemical safety goggles for concentrations of 5 ppm to 2% and a full facepiece for levels above 2%, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable concentration use a supplied-air respirator or SCBA with a full facepiece and operated in pressure-demand or other positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning!** Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other** Wear chemically protective gloves, boots, aprons, and gauntlets made of polyvinyl alcohol or Viton (breakthrough times > 1 hr) to prevent skin contact. **Ventilation** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾ **Safety Stations** Make available in the work area emergency eyewash stations, safety/quick-drench showers and washing facilities. **Contaminated Equipment** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements Prevent physical damage to containers. Store in lead-lined or mild steel containers of all-welded construction in a cool (<30°C), dry, well-ventilated area away from direct light and incompatibles. **Engineering Controls.** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Isolate operations involving chloroform. **Administrative Controls** It is suggested that chloroform use for extractions in labs should be avoided and replaced because of its toxicity and carcinogenic potential. Consider preplacement and periodic medical exams of exposed workers.

Transportation Data (49 CFR 172.101)**DOT Shipping Name** Chloroform**DOT Hazard Class** 6.1

UN1888

Packing Group II**DOT Label** Poison**Special Provisions** (172.102) N36 T14**Packaging Authorizations**

a) Exceptions None

b) Nonbulk Packaging 173.202

c) Bulk Packaging 173.243

Quantity Limitations

a) Passenger Aircraft or Railcar 5L

b) Cargo Aircraft Only 60L

Vessel Stowage Requirements

a) Vessel Stowage A

b) Other 40

MSDS Collection References 26 73 100 101, 103, 124, 126 127 132, 133 136 139 140 148 153, 159, 163, 164 167, 168, 169 171 174 175, 176 180

Prepared by M Gannon, BA, Industrial Hygiene Review PA Roy MPH CIH, Medical Review W Silverman, MD



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Material Safety Data Sheets Collection

Sheet No 83
Chromium Metal/Powder

Issued 3/81

Revision A, 11/89

Section 1. Material Identification

30

Chromium Metal/Powder Description Obtained from chrome ore chromite (FeCr_2O_4) by electrolysis of chromium solutions by direct reduction (ferrochrome), and by reducing the oxide with finely divided carbon or aluminum. Used for chromeplating other metals, for greatly increasing metal resistance and durability, in manufacturing chrome-steel or chrome-nickel-steel alloys (stainless steel), as a constituent of inorganic pigments, as protective coating for automotive and equipment accessories, and in nuclear and high-temperature research

Other Designations Chrome, Cr; CAS No 7440-47-3

Manufacturer Contact your supplier or distributor Consult the latest *Chemicalweek Buyers Guide* (Genium ref 73) for a suppliers list

R 1
I 4
S 1
K 1



Genium
HMIS
H 2
F 1
R 1
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Chromium metal/powder ca 100%

OSHA PEL ACGIH TLV, 1988-89*
8 hr TWA 1 mg/m³ TLV-TWA 0.5 mg/m³

NIOSH REL, 1987†
8-hr TWA (for chromium metal
and insoluble salts) 1 mg Cr/m³

Toxicity Data‡
Rat, implant, TD₀₁ 1200 µg/kg body weight
administered intermittently over six weeks

* This TLV is applicable to Cr²⁺ and Cr³⁺ compounds For water soluble and water insoluble Cr⁶⁺, the 8-hr TWA is 0.05 mg Cr⁶⁺/m³ Certain water-insoluble Cr⁶⁺ compounds (zinc chromate, calcium chromate, lead chromate, barium chromate, strontium chromate, and sintered chromium trioxide) are designated as A1a (human carcinogen)

† The NIOSH REL (10-hr TWA) for carcinogen Cr⁶⁺ compounds is 1 µg/m³ for noncarcinogenic Cr⁶⁺ compounds (including chromic acid) the RELs (10 hr TWAs) are 25 µg/m³ and 50 µg/m³ (15-min ceiling). The noncarcinogenic compounds include mono- and dichromates of hydrogen, cesium, sodium, lithium, potassium, rubidium, ammonia, and Cr⁶⁺ (chromic acid anhydride). Any and all Cr⁶⁺ materials excluded from the noncarcinogenic group above are carcinogenic Cr⁶⁺ compounds

‡ See NIOSH RTECS (GB4200000) for additional data with references to tumorigenic effects

Section 3. Physical Data

Boiling Point 4788 °F (2642 °C)

Atomic Weight 51.996 g/mol

Melting Point 3452 °F (1900 °C)

Specific Gravity (H₂O = 1 at 39 °F (4 °C)) 7.2 at 68 °F (20 °C)

Vapor Pressure 1 mm Hg at 2941 °F (1616 °C)

Water Solubility Insoluble

Vapor Density (Air = 1). 1.79

Appearance and Odor Steel-gray, lustrous metal, no odor

Section 4. Fire and Explosion Data

Flash Point None reported

Autoignition Temperature Cloud, 1076 °F (580 °C), dust
layer 752 °F (400 °C)

LEL Dust cloud explosion,
0.230 oz/ft³

UEL None reported

Extinguishing Media Use dry chemical or sand

Unusual Fire or Explosion Hazards Particle size and dispersion in air determine reactivity Chromium powder explodes spontaneously in air, while chromium dust suspended in CO₂ is ignitable and explosive when heated

Special Fire-fighting Procedures Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode

*One hundred percent of dust goes through a 74-µm sieve. A 140-mJ spark can ignite a dust cloud.

Section 5. Reactivity Data

Stability/Polymerization Chromium is stable when properly handled and stored. Hazardous polymerization cannot occur

Chemical Incompatibilities Chromium reacts readily with dilute, not nitric, acids to form chromous salts. It is soluble in acids (not nitric) and strong alkalis. Its powder is incompatible with strong oxidizing agents including high O₂ concentration. Evaporation of mercury (Hg) from Cr amalgam leaves pyrophoric chromium. Finely divided Cr attains incandescence with nitrogen oxide, potassium chlorate, and sulfur dioxide. Molten lithium at 18 °C severely attacks Cr. Fused ammonium nitrate below 200 °C reacts explosively and may ignite or react violently with bromine pentafluoride.

Hazardous Products of Decomposition Thermal oxidative decomposition of Cr can produce toxic chromium oxide fumes

Section 6. Health Hazard Data

Carcinogenicity The NTP and OSHA list chromium as a human carcinogen

Summary of Risks When ingested chromium is a human poison, with gastrointestinal (GI) effects Chromium 3 (Cr⁺³) compounds show little or no toxicity Less soluble chromium 6 (Cr⁺⁶) compounds are suspected carcinogens and severe irritants of the larynx nasopharynx, lungs and skin (Sec 2) Chromic acid or chromate salts cause irritation of the skin and respiratory passage Ingestion leads to severe irritation of the gastrointestinal tract, renal damage, and circulatory shock Chromium metal (when heated to high temperatures) and insoluble salts are said to be involved in histological fibrosis of the lungs, which may progress to clinically evident pneumoconiosis Exposure to chromate dust and powder can cause skin (dermatitis) and eye irritation (conjunctivitis)

Medical Conditions Aggravated by Long-Term Exposure An increased incidence of bronchogenic carcinoma occurs in workers exposed to chromate dust.

Target Organs. Respiratory system

Primary Entry Inhalation, percutaneous absorption, and ingestion.

Acute Effects Acute exposures to dust may cause headache coughing shortness of breath, pneumoconiosis fever weight loss nasal irritation, inflammation of the conjunctiva, and dermatitis

Chronic Effects Asthmatic bronchitis

FIRST AID

Eyes Flush immediately including under the eyelids gently but thoroughly with flooding amounts of running water for at least 15 min

Skin Brush off chromium dust. After rinsing affected area with flooding amounts of water, wash it with soap and water

Inhalation Remove exposed person to fresh air and support breathing as needed.

Ingestion Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person slowly drink 1 to 2 glasses of water to dilute Do not induce vomiting A physician should evaluate all ingestion cases

After first aid, get appropriate in-plant, paramedic, or community medical attention and support

Physician's Note Acute toxicity causes a two-phase insult. 1) multisystem shock due to gastrointestinal corrosivity and 2) hepatic, renal hematopoietic insult Treatment should use ascorbic acid as a neutralizer with gastric lavage If the ingestion is substantial exchange transfusions and/or consider hemodialysis Treat allergic dermatitis with local cortisone or 10% ascorbic acid to reduce Cr⁺⁶ to Cr⁺³ Ten percent EDTA in a lanolin base applied every 24 hr helps heal skin ulcers

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak Notify safety personnel of large spills Cleanup personnel should wear protective clothing and approved respirators Remove heat and ignition sources Provide adequate ventilation. Keep airborne dust at a minimum. Remove spills quickly and place in appropriate containers for disposal or reuse

Disposal Reclaim salvageable metal Contact your supplier or a licensed contractor for detailed recommendations Follow applicable Federal, state, and local regulations

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910 1000, Table Z-1)

EPA Designations

RCRA Hazardous Waste (40 CFR 261 33) Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302 4) Reportable Quantity (RQ) 1 lb (0 454 kg) [* per Clean Water Act, Sec 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355) Not listed

Listed as a SARA Toxic Chemical (40 CFR 372 65)

Section 8. Special Protection Data

Goggles Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910 133)

Respirator Wear a NIOSH-approved respirator if necessary Wear an SCBA with a full facepiece when the particle concentration's upper limit is 50 mg/m³

Warning Air-purifying respirators do not protect workers in oxygen-deficient atmospheres

Other Wear impervious rubber gloves boots aprons and gauntlets to prevent prolonged or repeated skin contact

Ventilation Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA standard (Sec 2) Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genum ref 103)

Safety Stations Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities

Contaminated Equipment Never wear contact lenses in the work area. soft lenses may absorb and all lenses concentrate, irritants Launder contaminated clothing before wearing Remove this material from your shoes and equipment.

Comments Never eat, drink, or smoke in work areas Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics

Section 9. Special Precautions and Comments

Storage Requirements Store material in cool dry, well-ventilated area separate from acids and oxidizing agents Seal and protect containers from physical damage. Keep away from heat or ignition sources

Engineering Controls Avoid dust inhalation Practice good housekeeping (vacuuming and wet sweeping) to minimize airborne particulates and to prevent dust accumulation Use nonsparking tools and ground electrical equipment and machinery

Transportation Data (49 CFR 172 101, 102) Not listed

MSDS Collection References. 1 2, 26 38, 80 87, 88, 89 100 109, 124 126

Prepared by MJ Allison, BS, Industrial Hygiene Review DJ Wilson, CIH, Medical Review MJ Hardies, MD

M8

Material Safety Data Sheet

From Genium's Reference Collection
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No 359

ETHYLENE DICHLORIDE
(Formerly 1,2-Dichloroethane)
(Revision C)

Issued November 1978

Revised August 1987

SECTION 1. MATERIAL IDENTIFICATION

CHEMICAL NAME ETHYLENE DICHLORIDE (Changed to reflect common industrial practice)

DESCRIPTION (Origin/Uses) Made from acetylene and HCl Used as a degreaser, a scavenger in leaded gasoline, as an intermediate in the manufacture of vinyl chloride, in paint removers, in wetting and penetration agents, in ore flotation processes, as a fumigant, and as a solvent for fats, oils, waxes, and gums

OTHER DESIGNATIONS 1,2-Dichloroethane, *sym*-Dichloroethane, Dutch Liquid, Dutch Oil, EDC,

Ethane Dichloride, Ethylene Chloride, 1,2-Ethylene Dichloride, Glycol Dichloride, $C_2H_4Cl_2$,

NIOSH RTECS KI0525000, CAS #0107-06-2

MANUFACTURERS/SUPPLIERS Available from several suppliers, including

Dow Chemical USA, 2020 Dow Center, Midland, MI 48640, Telephone (517) 636-1000



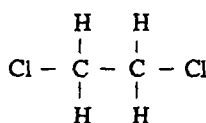
HMIS	R	1
H 1	I	4
F 3	S	2
R 0	K	4
PPE*		

* See Sect. 8

COMMENTS Ethylene dichloride is a flammable, toxic liquid

SECTION 2. INGREDIENTS AND HAZARDS

Ethylene Dichloride, CAS #0107-06-2, NIOSH RTECS #KI0525000



*The maximum allowable peak concentration (above the ceiling level value) of ethylene dichloride is 200 ppm for 5 minutes in any 3-hour period

COMMENTS Additional data concerning toxic doses and tumorigenic, reproductive, and mutagenic effects is listed (with references) in the NIOSH RTECS 1983-84 supplement, pages 865-66

%

HAZARD DATA

100

ACGIH Values 1987-88

TLV-TWA 10 ppm, 40 mg/m³

OSHA PEL* 1986-87

8-Hr TWA 50 ppm,

Ceiling 100 ppm (15 Min)

NIOSH REL 1986-87

10-Hr TWA 1 ppm

Ceiling 2 ppm (15 Min)

Toxicity Data

Man, Inhalation, TC_{Lo} 4000 ppm/1 HrHuman, Oral, TD_{Lo} 428 mg/kgMan, Oral, TD_{Lo} 892 mg/kgMan, Oral, LD_{Lo} 714 mg/kgRat, Oral, LD₅₀ 670 mg/kg

SECTION 3. PHYSICAL DATA

Boiling Point 182.3°F (83.5°C)

Vapor Pressure 87 Torr at 77°F (25°C)

Water Solubility Soluble in about 120 Parts Water

Vapor Density (Air = 1) 3.4

Appearance and odor Colorless, clear liquid Sweet, chloroformlike odor is typical of chlorinated hydrocarbons The recognition threshold (100% of test panel) for ethylene dichloride is 40 ppm. Odor detection probably indicates an excessive exposure to vapor High volatility and flammability, coupled with its toxicity and carcinogenic potential, make this material a major health hazard

COMMENTS Ethylene dichloride is miscible with alcohol, chloroform, and ether

Evaporation Rate (n-BuAc = 1) .. Not Listed

Specific Gravity 1.2569 at 69°F (20°C)

Freezing Point -31.9°F (-35.5°C)

Molecular Weight 98.96 Grams/Mole

SECTION 4. FIRE AND EXPLOSION DATA

LOWER

UPPER

Flash Point and Method

Autoignition Temperature

Flammability Limits in Air

See Below

775°F (413°C)

% by Volume

6.2

15.9

EXTINGUISHING MEDIA Use chemical, carbon dioxide, alcohol foam, water spray/fog, or dry sand to fight fires involving ethylene dichloride Direct water sprays may be ineffective extinguishing agents, but they may be successfully used to cool fire-exposed containers Use a smothering effect to extinguish fires involving this material **UNUSUAL FIRE/EXPLOSION**

HAZARDS Ethylene dichloride is a dangerous fire and explosion hazard when exposed to sources of ignition such as heat, open flames, sparks, etc Its vapors are heavier than air and can flow along surfaces to distant, low-lying sources of ignition and flash back. If it is safe to do so, remove this material from the fire area Ethylene dichloride burns with a smoky flame

SPECIAL FIRE-FIGHTING PROCEDURES Wear a self-contained breathing apparatus with a full facepiece operated in a pressure-demand or another positive-pressure mode

COMMENTS Flash Point and Method 56°F (13°C) CC, 65°F (18°C) OC

OSHA Flammability Class (29 CFR 1910.106) IB DOT Flammability Class (49 CFR 173.115) Flammable Liquid

SECTION 5. REACTIVITY DATA

Ethylene dichloride is stable Hazardous polymerization cannot occur

CHEMICAL INCOMPATIBILITIES include strong oxidizing agents Explosions have occurred with mixtures of this material and liquid ammonia or dimethylaminopropylamine Finely divided aluminum or magnesium metal may be hazardous in contact with ethylene dichloride

CONDITIONS TO AVOID Eliminate sources of ignition such as excessive heat, open flames, or electrical sparks, particularly in low-lying areas, because the explosive, heavier-than-air vapors will concentrate there

PRODUCTS OF HAZARDOUS DECOMPOSITION can include vinyl chloride, chloride fumes, and phosgene Phosgene is an extremely poisonous gas Products of thermal-oxidative degradation (i.e., fire conditions) must be treated with appropriate caution

No 359 8/87 ETHYLENE DICHLORIDE

SECTION 6 HEALTH HAZARD INFORMATION

Ethylene dichloride is listed as an anticipated human carcinogen by the NTP and as a probable human carcinogen (Group 2B), by the IARC. It was found to be an animal-positive carcinogen by the IARC. NCI reported positive results (mouse, rat) from its carcinogenesis bioassay. **SUMMARY OF RISKS** Ethylene dichloride is considered to be one of the more toxic of the common chlorinated hydrocarbons. Deaths from accidental ingestion of this material have been reported. Inhalation of vapors reportedly caused three fatalities. Excessive inhalation of ethylene dichloride vapors can cause respiratory irritation, intoxication, narcotic and anesthetic effects, vomiting, dizziness, depression, and diarrhea. The hepatotoxic (injurious to liver) effects of this material are significant. The systemic effects from overexposure can appear in the liver, kidneys, digestive tract, blood, lungs, adrenal glands, and the central nervous system. Tests on animals have revealed reproductive failure and fetal resorption. There may be increased risk to nursing infants of exposed mothers. **TARGET ORGANS** Central nervous system, eyes, kidneys, liver, heart, adrenal glands, and skin. **PRIMARY ENTRY** Inhalation, absorption through skin, oral, or eye contact. **ACUTE EFFECTS** Skin contact causes irritation, defatting, and, if repeated or prolonged, burning. Eye contact causes irritation and serious injury (clouding of the cornea) if it is not removed promptly. **CHRONIC EFFECTS** Injuries to the liver (hepatotoxicity) and kidneys, weight loss, low blood pressure, jaundice, oliguria (reduced excretion of urine), or anemia. **MEDICAL CONDITIONS AGGRAVATED BY LONG-TERM EXPOSURE** Persons taking anticoagulants could experience an increase in tendency to bleed. Persons taking insulin face an increased risk of lowered blood sugar. **FIRST AID** Be prepared to restrain a hyperactive victim. **EYE CONTACT** Flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. Get medical help. **SKIN CONTACT** Immediately flush the affected area with water. Wash thoroughly with soap and water. Remove and launder contaminated clothing before wearing it again, clean material from shoes and equipment. Get medical help. **INHALATION** Remove victim to fresh air; restore and/or support his breathing as needed. Get medical help. **INGESTION** Never give anything by mouth to someone who is unconscious or convulsing. Rinse victim's mouth with water. Oxygen and artificial respiration may be needed. Get medical help. * GET MEDICAL ASSISTANCE = IN PLANT, PARAMEDIC, COMMUNITY. Get prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7 SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK Before using ethylene dichloride, it is essential that proper emergency procedures be established and made known to all personnel involved in handling it. Notify safety personnel of ethylene dichloride spills or leaks and implement containment procedures. Remove and eliminate all possible sources of ignition such as heat, sparks, and open flames from the area. Cleanup personnel should use protection against inhalation of vapors and contact with liquid. Contain spills by using an absorbent material such as dry sand or vermiculite. Use nonsparking tools to mix waste material thoroughly with absorbent and place it in an appropriate container for disposal. Flush trace residues with large amounts of water. Do not flush waste to sewers or open waterways. **WASTE DISPOSAL** Consider reclamation, recycling, or destruction rather than disposal in a landfill. Waste may be burned in an approved incinerator equipped with an afterburner and a scrubber. Follow Federal, state, and local regulations. Ethylene dichloride is designated as a hazardous substance by the EPA (40 CFR 116.4). Ethylene dichloride is reported in the 1983 EPA TSCA Inventory. EPA Hazardous Waste Number (40 CFR 261.33) U077. EPA Reportable Quantity (40 CFR 117.3) 5000 lbs (2270 kgs). Aquatic Toxicity Rating, TLM 96 1000 - 100 ppm.

SECTION 8 SPECIAL PROTECTION INFORMATION

GOGGLES Always wear protective eyeglasses or chemical safety goggles. Ethylene dichloride is particularly harmful to the eyes, and direct contact results in corneal opacity (permanent clouding of the eye). **GLOVES** Wear impervious rubber gloves to prevent skin contact. **RESPIRATOR** Use a NIOSH-approved respirator per the NIOSH Pocket Guide to Chemical Hazards (Genium ref 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. Any detectable concentration of ethylene dichloride requires an SCBA, full facepiece, and pressure-demand/positive-pressure modes. Warning: Air-purifying respirators will not protect workers from oxygen-deficient atmospheres. **OTHER** Wear rubber boots, aprons, and other protective clothing suitable for use conditions to prevent skin contact. Remove contaminated clothing and launder it before wearing it again. Discard contaminated shoes. **VENTILATION** Provide maximum explosion-proof local fume exhaust ventilation systems to maintain the airborne concentrations of ethylene dichloride vapors below the exposure limits cited in section 2. Install properly designed hoods that maintain a minimum face velocity of 100 fpm (linear feet per minute). **SAFETY STATIONS** Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. **SPECIAL CONSIDERATIONS** Vapors are heavier than air and will collect in low-lying areas. Eliminate sources of ignition in these areas and again provide good ventilation there. **COMMENTS** Practice good personal hygiene. Keep materials off of your clothes and equipment. Avoid transferring this material from hands to mouth while eating, drinking, or smoking. Immediately remove ethylene dichloride-saturated clothing to avoid flammability and health hazards. Contact lenses pose a special hazard, soft lenses may absorb irritants, and all lenses concentrate them.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION Store ethylene dichloride in tightly closed containers in a cool, dry, well-ventilated area away from sources of ignition. Protect containers from physical damage and from exposure to excessive heat. Avoid direct physical contact with strong acids, bases, oxidizing agents, and reducing agents. **SPECIAL HANDLING/STORAGE** Use nonsparking tools. Outside or detached storage is preferred. Store and handle ethylene dichloride in accordance with the regulations concerning OSHA class IB flammable liquids. **ENGINEERING CONTROLS** During transfer operations involving ethylene dichloride, the liquid and its vapors must not be exposed to nearby sources of ignition from engineering systems that are not explosion proof. Preplan emergency response procedures. **TRANSPORTATION DATA** (per 49 CFR 172.101-2)
DOT Hazard Class Flammable Liquid
DOT Label Flammable Liquid
IMO Class 3.2

DOT Shipping Name Ethylene Dichloride
DOT ID No UN 1184
IMO Label Flammable Liquid, Poison

References 1-9 12, 19, 21, 26, 43, 47, 73, 87-102 CK

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Approvals JO Accorco

Indust Hygiene/Safety J/W 11-18-87

Medical Review G. H. Goldsmith 11-30-87

Material Safety Data Sheet

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GENIUM PUBLISHING CORP

No 26

15 of 24

MERCURY
(Revision C)
Issued September 1981
Revised August 1988

SECTION 1. MATERIAL IDENTIFICATION

Material Name MERCURY

Description (Origin/Uses) Used in barometers, thermometers, hydrometers, and pyrometers, in mercury arc lamps producing ultraviolet rays, in switches and fluorescent lamps, as a catalyst in oxidations of organic compounds, in alloys, in explosives, and for extracting gold and silver from ore

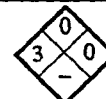
Other Designations Colloidal Mercury, Metallic Mercury, Quicksilver, Hg, Hydrargyrum,

CAS No 7439-97-6

Manufacturer Contact your supplier or distributor Consult the latest edition of the *Chemicalweek*

Buyers Guide (Genium ref 73) for a list of suppliers

Comments Inorganic and organic mercury compounds are highly toxic, as is pure mercury



Genium

HMIS

H 3 R 1

F 0 I 4

R 0 S 1

PPG* K 0

*See sect 8

SECTION 2. INGREDIENTS AND HAZARDS

Mercury, CAS No 7439-97-6

%

EXPOSURE LIMITS

OSHA PEL
Ceiling 1 mg per 10 m³

ACGIH TLV (Skin*), 1987-88
TLV-TWA 0.05 mg/m³ as Hg (Mercury Vapor)

Toxicity Data**
Rabbit, Inhalation, LC₅₀ 29 mg/m³
(30 Hrs)

*Mercury can be absorbed through intact skin, which contributes to overall exposure

**See NIOSH, RTECS (OV4550000), for additional data with references to reproductive, mutagenic, and tumorigenic effects

SECTION 3. PHYSICAL DATA

Boiling Point 673°F (357°C)

Specific Gravity (H₂O = 1) 13.546 at 68°F (20°C)

Vapor Pressure 0.0018 Torr at 77°F (25°C)

Water Solubility (%) Insoluble

Molecular Weight 201 Grams/Mole

Melting Point -37.93°F (-38.85°C)

Appearance and Odor A silver, heavy liquid, odorless Danger Mercury vapor has no warning properties

SECTION 4. FIRE AND EXPLOSION DATA

LOWER

UPPER

Flash Point and Method

Autoignition Temperature

Flammability Limits in Air

*

*

% by Volume

*

*

Extinguishing Media *Mercury does not burn Use extinguishing agents that will put out the surrounding fire

Unusual Fire or Explosion Hazards When exposed to the high temperatures that occur during a fire, mercury can vaporize to form extremely toxic fumes

Special Fire-fighting Procedures Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode

SECTION 5. REACTIVITY DATA

Mercury is stable in closed containers at room temperature under normal storage and handling conditions It cannot undergo hazardous polymerization

Chemical Incompatibilities Hazardous reactions involving mercury and acetylene, ammonia, boron phosphodiiodide, chlorine, chlorine dioxide, methyl azide, sodium carbide, nitric acid, oleum, and sulfuric acid are reported (Genium ref 84)

Conditions to Avoid Do not expose mercury to incompatible chemicals

Hazardous Products of Decomposition Extremely toxic mercury metal fumes are likely to be produced during fires

SECTION 6. HEALTH HAZARD INFORMATION

Mercury is not listed as a carcinogen by the NTP, IARC, or OSHA

Summary of Risks Mercury is very toxic due to its liquid and fat solubility, lack of charge, and membrane permeability. It is a slowly cumulative poison that concentrates in the brain, kidneys, and liver. It is very hazardous when spilled or heated. Mercury and its vapor are rapidly absorbed by the membranes lining the respiratory tract, the gastrointestinal (GI) tract, and the skin. Mercury is a teratogen (causes physical defects in embryos). **Medical Conditions Aggravated by Long-Term Exposure** Preexisting problems of the target organs can be worsened. Provide preplacement and periodic medical exams emphasizing the target organs. **Target Organs** Skin, eyes, respiratory system, central nervous system (CNS), kidneys. **Primary Entry** Skin absorption/contact, inhalation. **Acute Effects** Erosion of the respiratory/GI tracts, nausea, vomiting, bloody diarrhea, shock, headache, metallic taste. **Inhalation** of high concentrations for short periods can cause pneumonitis, chest pain, dyspnea, coughing, stomatitis, gingivitis, and salivation. **Chronic Effects** Tremors, emotional problems, loss of concentration, depression, drowsiness, fatigue, insomnia, loss of memory, kidney problems, eye lesions, vision disturbances, sore mouth and throat, problems with the sense of taste or smell, nosebleeds, nasal inflammation, loss of weight or appetite, poor hand-eye coordination, awkwardness, and unsteadiness, as well as dermatitis. **FIRST AID** **Eyes** Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin** Immediately wash the affected area with soap and water because of the increased exposure from skin absorption. **Inhalation** Remove exposed person to fresh air, restore and/or support his or her breathing as needed. Have medical personnel administer oxygen to treat the chemical pneumonitis that may develop. **Ingestion** Never give anything by mouth to someone who is unconscious or convulsing. **Note to physician** If indicated by degree of ingestion, saline cathartics and charcoal should be used. Chelation therapy with D-penicillamine may also be indicated.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES Seek prompt medical assistance for further treatment, observation, and support after first aid. Treatment of chronic mercury poisoning requires expert medical care. At the first signs, immediately remove the exposed person from further exposure and have him or her examined and treated by a physician trained in occupational mercury poisoning.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak Notify safety personnel, restrict access to the spill area to necessary personnel, and provide adequate ventilation. Clean up spills promptly. Specialized equipment and/or techniques may be required to safely deal with large mercury spills, if large quantities of mercury are used in the workplace; detailed, prior spill-management planning is recommended. Collect spilled mercury by using a suction pump and an aspirator bottle with a long capillary tube. For finely divided mercury in inaccessible cracks, corners, etc., treatment with calcium polysulfide and excess sulfur is recommended to convert the mercury globules into mercury sulfide. Vacuum cleaners may be used if they are equipped with specially designed mercury-absorbent exhaust filters. Collect the mercury into tightly sealed containers for later disposal or reclamation. Cleanup personnel must use the recommended personal protective equipment (see sect. 8).

Waste Disposal Consider reclamation, recycling, or destruction rather than disposal in a landfill. Do not pour mercury down a drain. Mercury is very harmful to the environment. Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 19010 1000 Subpart Z)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste No. U151

CERCLA Hazardous Substance, Reportable Quantity 1 lb (0.454 kg)*

*Per the Clean Water Act, § 407 (a), Clean Air Act, § 112, and Resource Conservation and Recovery Act, § 3001

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles Always wear protective eyeglasses or chemical safety goggles. Where splashing of mercury may occur, wear a full face shield or splash guard. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). **Other** Wear impervious gloves, boots, aprons, gauntlets, etc., to prevent any contact with mercury and the skin.

Ventilation Install and operate general and local ventilation systems powerful enough to continuously maintain airborne levels of mercury below the OSHA PEL standard cited in section 2.

Safety Stations Make emergency eyewash stations, washing facilities, and safety/quick-drench showers available in work areas.

Contaminated Equipment Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do not wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean mercury from shoes and equipment. Separate work and street clothes; store work clothes in special lockers and always shower before changing to street clothes.

Comments Practice good personal hygiene, always wash thoroughly after using this material. Keep it off of your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do not eat, drink, or smoke in any work area.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation Store mercury in a cool, dry, well-ventilated area in tightly closed unbreakable polyethylene containers. Protect these containers from physical damage.

Special Handling/Storage Construct storage areas to have smooth, hard, nonporous floors with no cracks or spaces so that spilled mercury globules do not form in inaccessible areas.

Comments Mercury evaporates slowly, but if it is spilled it can form many tiny globules that evaporate much faster than a single pool of it will. In an unventilated area, significant concentration of mercury vapor can develop from this enhanced evaporation effect. This poisonous vapor is particularly hazardous if breathed over a long period of time, so spills or releases of mercury require very meticulous cleaning procedures.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name Mercury, Metal

DOT Label None

IMO Class 8

DOT Hazard Class ORM-B

DOT ID No. NA2809

IMO Label Corrosive

References 1, 2, 8, 26, 38, 84-94, 100

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Material Safety Data Sheets Collection

Sheet No 311
Methyl Chloroform

Issued 11/75 Revision F, 3/92 Errata 6/92

Section 1. Material Identification

38

Methyl Chloroform ($C_2H_3Cl_3$) Description Derived by catalytic addition of hydrogen chloride to 1,1-dichloroethylene or by re-fluxing chlorine monoxide with carbon tetrachloride and chloroethane. Available in technical and solvent grades which differ only in the amount of stabilizer added to prevent metal parts corrosion. Used as a solvent for oils, waxes, tars, cleaning precision instruments, and pesticides, as a component of inks and drain cleaners, in degreasing metals, and textile processing. In recent years, methyl chloroform has found widespread use as a substitute for carbon tetrachloride.

Other Designations CAS No 71-55-6, α -trichloroethane, Inhibisol, 1,1,1-trichloroethane, Strobane.

Manufacturer Contact your supplier or distributor. Consult latest *Chemical Week Buyers Guide*⁽⁷³⁾ for a suppliers list.

Cautions Methyl chloroform is a skin, eye, and respiratory tract irritant and can become narcotic with an anesthetic effect at high concentrations.

* Data on skin absorption via methyl chloroform is conflicting⁽¹³³⁾. Some studies show definite absorption where others don't.

R	1	Genium
I	2	
S	2*	
K	1	
HMIS		
H	2	
F	1	
R	1	
PPG*		
* Sec. 8		

Section 2. Ingredients and Occupational Exposure Limits

Methyl chloroform, ca 92 to 97%*

1990 OSHA PELs

8-hr TWA 350 ppm (1900 mg/m³)

15-min STEL 450 ppm (2450 mg/m³)

1990 IDLH Level

1000 ppm

1990 NIOSH REL

15-min Ceiling 350 ppm (1900 mg/m³)

1991-92 ACGIH TLVs

TWA 350 ppm (1910 mg/m³)

STEL 450 ppm (2460 mg/m³)

1990 DFG (Germany) MAKs

TWA 200 ppm (1080 mg/m³)

Half-life 2 hr to shift length

Peak Exposure Limit 1000 ppm/30 min (average value)/2 per shift

1985 86 Toxicity Data†

Human, oral, TD_{Lo} 670 mg/kg produced diarrhea, nausea, and vomiting

Human, inhalation, LC_{Lo} 27 g/m³/10 min, toxic effects not yet reviewed

Man, eye 450 ppm/8 hr produced irritation

Rat, inhalation, TC_{Lo} 2100 ppm/24 hr for 14 days prior to mating and from 1 to 20 days of pregnancy produced specific developmental abnormalities of the musculoskeletal system

* Methyl chloroform usually contains inhibitors (3 to 8%) to prevent corrosion of aluminum and some other metals. Typical inhibitors are nitromethane, butylene oxide, secondary butyl alcohols, ketones, and glycol diesters.

† See NIOSH RTECS (KJ2975000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point 165 °F (75 °C)

Freezing Point -22 °F (-30 °C)

Vapor Pressure 100 mm Hg at 68 °F (20 °C)

Vapor Density (air = 1) 4.55

Corrosivity Readily corrodes aluminum and its alloys

Refraction Index 1.43765 at 69 °F (21 °C)

Viscosity 0.858 cP at 68 °F (20 °C)

Appearance and Odor Colorless liquid with a sweetish, chloroform-like odor. The odor threshold is 44 ppm.

Molecular Weight 133.42

Density 1.3376 at 68/39 °F (20/4 °C)

Water Solubility Insoluble

Other Solubilities Soluble in acetone, alcohol, ether, benzene, carbon tetrachloride, and carbon disulfide

% in Saturated Air 16.7% at 77 °F (25 °C)

Relative Evaporation Rate (butyl acetate = 1) 12.8

Section 4. Fire and Explosion Data

Flash Point None (in conventional CC tests)

Autoignition Temperature 932 °F (500 °C)

LEL 7% v/v

UEL 16% v/v

Extinguishing Media *Noncombustible liquid* whose vapor burns in the presence of excess oxygen or a strong ignition source. For small fires use dry chemical or carbon dioxide (CO_2). For large fires use fog or regular foam. If these materials are unavailable, a water spray may be used but be aware that water reacts slowly with methyl chloroform to release hydrochloric acid.

Unusual Fire or Explosion Hazards Vapors are heavier than air and may travel to a strong ignition source and flash back. Air/vapor mixtures may explode when heated. Container may explode in heat of fire. Exposure to open flames or arc welding can produce hydrogen chloride and phosgene.

Special Fire-fighting Procedures Methyl chloroform's burning rate is 2.9 mm/min. Since fire may produce toxic thermal decomposition products wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides limited protection. Wear clothing specifically recommended by the manufacturer for use in fires involving methyl chloroform. Apply cooling water to container sides until after fire is extinguished. Stay away from ends of tanks. Isolate area for 1/2 mile if fire involves tank, truck, or rail car. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization Methyl chloroform is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization can occur in contact with aluminum trichloride.

Chemical Incompatibilities Methyl chloroform is incompatible with sodium hydroxide, nitrogen tetroxide, oxygen (liquid or gas), strong oxidizers and chemically active metals like aluminum, zinc, and magnesium powders. reacts violently with caustics to form dichloroacetylene, reacts slowly with water to form hydrochloric acid, forms shock sensitive mixtures with potassium, and polymerizes in contact with aluminum trichloride.

Conditions to Avoid Exposure to moisture, strong ignition sources and arc-welding units and contact with incompatibles.

Hazardous Products of Decomposition Thermal oxidative decomposition (temperatures >500 °F, contact with hot metals, or under UV rays) of methyl chloroform can produce carbon dioxide (CO_2) and toxic dichloroacetylene, hydrogen chloride, and phosgene gases.

Section 6. Health Hazard Data

Carcinogenicity The IARC (Class 3, inadequate evidence)⁽¹⁶⁴⁾, NTP⁽¹⁴²⁾ and OSHA⁽¹⁶⁴⁾ do not list methyl chloroform as a carcinogen.

Summary of Risks Methyl chloroform is considered one of the least toxic of the liquid chlorinated hydrocarbons. It is irritating to eyes, skin, and respiratory tract. Although low in systemic toxicity, methyl chloroform is an anesthetic capable of causing death at high concentrations (>15,000 ppm) generally in poorly ventilated enclosed areas. Quick and complete recovery is observed after prompt removal of unconscious persons from area of exposure. Like many other solvents, methyl chloroform sensitizes the heart to epinephrine (blood pressure-raising hormone) and may induce cardiac arrhythmias and arrest.

Medical Conditions Aggravated by Long-Term Exposure None reported.

Target Organs Skin, eyes, central nervous (CNS) and cardiovascular (CVS) systems.

Continue on next page

Section 6. Health Hazard Data, continued

Primary Entry Routes Inhalation skin contact. **Acute Effects** Methyl chloroform defats the skin causing irritation, redness, dryness, and scaling. Contact with eyes produces irritation and mild conjunctivitis. Vapor inhalation can cause headache, dizziness, equilibrium disturbances, and in high concentrations may lead to CNS depression, unconsciousness, and coma. During a 60-min exposure period these effects are observed. 100 ppm is the observed odor threshold, at 500 ppm there is obvious odor and decreased reaction time, 1000 ppm causes slight equilibrium loss, at 5000 ppm there is definite incoordination, and 20,000 ppm produces surgical strength anesthesia with possible death. Mild liver and kidney dysfunction may occur after CNS depression recovery. Although unlikely, if ingestion occurs, symptoms include nausea, vomiting, diarrhea and possible esophageal burns. The acute lethal human dose is ~500 to 5000 mg/kg. **Chronic Effects** None reported.

FIRST AID

Eyes Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Do not allow victim to rub or keep eyes tightly shut. Consult a physician immediately. **Skin** Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation** Remove exposed person to fresh air and support breathing as needed. **Ingestion** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center, and unless otherwise advised, have that conscious and alert person drink 1 to 2 glasses of water to dilute. When deciding whether to induce vomiting, carefully consider amount ingested, time since ingestion, and availability of medical help. If large amounts are recently ingested (absorption into the body is not yet likely to have occurred), and medical help or transportation to a medical facility is not readily available, induce vomiting. Otherwise, vomiting is not recommended since aspiration of vomitus can produce chemical pneumonitis. **Note to Physicians** Do not use adrenaline or sympathomimetic amines in treatment because of the increased cardiac sensitivity involved.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak Immediately notify safety personnel, isolate area, deny entry, and stay upwind. Shut off all ignition sources. If possible without risk, shut off leak. Cleanup personnel should wear fully encapsulating vapor-protective clothing. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material. Using nonsparking tools, place in suitable containers for disposal or reclamation. For large spills, dike far ahead of liquid spill for later disposal or reclamation. Report any release in excess of 1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport** In water, methyl chloroform's half-life is hours to weeks depending on wind and mixing conditions. It is very persistent in groundwater. On land it volatilizes due to its high vapor pressure and leaches extensively. When released to the atmosphere, methyl chloroform can be transported long distances and returned to earth via rain. It is slowly degraded by reaction with hydroxyl radicals and has a half-life of 6 months to 25 years. The Natural Resources Defense Council reported recently that methyl chloroform depletes ozone.

Ecotoxicity Values *Pimephales promelas* (fathead minnow), LC₅₀ 52.8 mg/L/96 hr; *Poecilia reticulata* (guppy), LC₅₀ 133 ppm/7 day.

Disposal Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33) No. U226

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4) Reportable Quantity (RQ), 1000 lb (454 kg) [* per RCRA, Sec. 3001, CWA, Sec. 307(a) and CAA, Sec. 112]

SARA Extremely Hazardous Substance (40 CFR 355) Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Section 8. Special Protection Data

Goggles Wear splash-proof, protective chemical safety goggles or faceshields, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.

Respirator Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions: level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning!** Air purifying respirators do not protect workers in oxygen-deficient atmospheres. If respirators are used, OSHA requires a respiratory protection program that includes at least: training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Other Wear chemically protective gloves, boots, aprons and gauntlets to prevent repeated or prolonged skin contact. Viton and butyl rubber [with breakthrough times (BTs) of >8 hr and 4 to 7.9 hr, respectively] are recommended materials for protective gear. Do not use neoprene, polyvinyl chloride (PVC), natural rubber, or polyethylene because these materials have a BT of <1 hr.

Ventilation Provide general and local exhaust (in some cases explosion-proof) ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into work area by controlling it at its source.⁽¹⁰³⁾

Safety Stations Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment.

Comments Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements Prevent physical damage to containers. Store in cool, dry, well-ventilated (use pressure-vacuum ventilation) area away from ignition sources, arc-welding operations, and incompatibles (Sec. 5). Regularly monitor inhibitor levels. Do not store in aluminum containers or use pressure-spraying equipment when methyl chloroform is involved.

Engineering Controls To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. To prevent static sparks, electrically ground and bond all equipment used in methyl chloroform manufacturing, use, storage, transfer and shipping.

Administrative Controls Consider preplacement and periodic medical exams of exposed workers that emphasize CNS, CVS, liver and skin.

Transportation Data (49 CFR 172.101, 102)

DOT Shipping Name 1,1,1-Trichloroethane

DOT Hazard Class ORM-A

ID No. UN2831

DOT Label None

DOT Packaging Exceptions 173.505

DOT Packaging Requirements 173.605

IMO Shipping Name 1,1,1-Trichloroethane

IMO Hazard Class 6.1

ID No. UN2831

IMO Label St. Andrews Cross

IMDG Packaging Group III

MSDS Collection References 26 38 73 89 100 101 103 124 126 127 132 133 136 148 153 159 162 163 164

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64



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Material Safety Data Sheets Collection:

Sheet No. 313
Perchloroethylene

Issued 11/78

Revision E, 9/92

Section 1. Material Identification

Perchloroethylene (C₂Cl₄) Description By chlorination of hydrocarbons and pyrolysis of the carbon tetrachloride that is formed, or by catalytic oxidation of 1,1,2,2-tetrachloroethane. Used in dry cleaning and textile processing, metal degreasing, insulating fluid and cooling gas in electrical transformers, production of adhesives, aerosols, paints, and coatings, as a chemical intermediate, a solvent for various applications, extractant for pharmaceuticals, a pesticide intermediate, and an anthelmintic (parasitic worm removal) agent in veterinary medicine.

Other Designations CAS No 127-18-4, Ankilostin, carbon dichloride, Ddakene, ethylene tetrachloride, Perchlor, Perclene, Perk, Tetracap, tetrachloroethylene.

Manufacturer. Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*⁽⁷³⁾ for a suppliers list.

R	1	NFPA
I	3	
S	2*	
K	0	
* Skin absorption		
		HMS
		H 2†
		F 0
		R 0
		PPE†
		† Chronic effects
		† Sec. 8

Cautions. Perchloroethylene is a central nervous system depressant, causes liver and kidney damage (from acute or chronic exposures), and is considered an IARC Class 2B carcinogen (animal sufficient evidence, human inadequate data)

Section 2. Ingredients and Occupational Exposure Limits

Perchloroethylene, < 99% Impurities include a small amount of amine or phenolic stabilizers

1991 OSHA PEL
8-hr TWA 25 ppm (170 mg/m³)
1990 IDLH Level
500 ppm
1990 NIOSH REL
NIOSH-X Carcinogen
Limit of Quantitation 0.4 ppm

1992-93 ACGIH TLVs
TWA 50 ppm (339 mg/m³)
STEL 200 ppm (1357 mg/m³)
1990 DFG (Germany) MAK
TWA 50 ppm (345 mg/m³)
Category II. substances with systemic effects
Half-life < 2 hr
Peak Exposure Limit: 100 ppm 30 min average value, 4/shift

1985-86 Toxicity Data*
Man, inhalation, TC_{Lo} 280 ppm/2 hr caused conjunctival irritation and anesthesia.
Human, lung 100 mg/L caused unscheduled DNA synthesis.
Rat, oral, LD₅₀ 3005 mg/kg, caused somnolence, tremor, and ataxia.
Rat, inhalation, TC_{Lo} 200 ppm/6 hr given intermittently over 2 years produced leukemia and testicular tumors
Rabbit, eye 162 mg caused mild irritation.
Rabbit, skin 810 mg/24 hr caused severe irritation.

* See NIOSH, RTECS (KX3850000) for additional irritation, mutation, reproductive tumorigenic & toxicity data.

Section 3. Physical Data

Boiling Point: 250 °F (121.2 °C)
Freezing Point -8 °F (-23.35 °C)
Vapor Pressure 13 mm Hg at 68 °F (20 °C)
Surface Tension 31.74 dyne/cm at 68 °F (20 °C)
Viscosity 0.84 cP at 77 °F (25 °C)
Refraction Index 1.50534 at 68 °F (20 °C)
Molecular Weight. 165.82

Density 1.6311 at 59 °F (15.4 °C)
Water Solubility 0.02% at 77 °F (25 °C)
Other Solubilities Miscible with alcohol, ether, benzene, chloroform, and oils.
Odor Threshold 47 to 71 ppm (poor warning properties since olfactory fatigue is probable)
Evaporation Rate 0.15 gal/ft²/day at 77 °F (25 °C)
Saturated Vapor Density (Air = 0.075 lb/ft³ or 1.2 kg/m³) 0.081 lb/ft³ or 1.296 kg/m³

Appearance and Odor: Colorless liquid with an ether-like odor

Section 4. Fire and Explosion Data

Flash Point: Nonflammable **Autoignition Temperature** Nonflammable **LEL:** None reported **UEL:** None reported

Extinguishing Media For small fires, use dry chemical, carbon dioxide (CO₂). For large fires, use water spray, fog, or regular foam

Unusual Fire or Explosion Hazards Vapors are heavier than air and collect in low-lying areas

Special Fire-fighting Procedures Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Apply cooling water to sides of container until well after fire is out. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways

Section 5. Reactivity Data

Stability/Polymerization Perchloroethylene is stable up to 932 °F (500 °C) in the absence of catalysts, moisture, and oxygen but deteriorates rapidly in warm, moist climates. It is slowly decomposed by light. Amine or phenolic stabilizers are usually added. Hazardous polymerization cannot occur. **Chemical Incompatibilities** Slowly (faster in presence of water) corrodes aluminum, iron, and zinc. It is incompatible with chemically active metals (i.e., barium, beryllium, and lithium (explodes with lithium shavings), strong oxidizers, sodium hydroxide, caustic soda, potash, and nitric acid. Perchloroethylene forms an explosive mixture with dinitrogen tetroxide and reacts with activated charcoal at 392 °F (200 °C) to yield hexachloroethane and hexachlorobenzene. **Conditions to Avoid** Contact with moisture and incompatibles
Hazardous Products of Decomposition Thermal oxidative decomposition of perchloroethylene can produce carbon dioxide and toxic chlorine, hydrogen chloride, and phosgene gas (also produced by contact with UV light)

Section 6. Health Hazard Data

Carcinogenicity. Perchloroethylene is listed as a carcinogen by The IARC (Group 2B, animal sufficient evidence, human inadequate data),⁽¹⁶⁴⁾ NTP (Class 2 reasonably anticipated as a carcinogen, with limited human evidence and sufficient animal evidence),⁽¹⁶⁵⁾ NIOSH (Class-X, carcinogen defined with no further explanation),⁽¹⁶⁶⁾ and DFG (MAK-B, justifiably suspected of having carcinogenic potential)⁽¹⁶⁷⁾ There is some controversy regarding human carcinogenicity because even though there is an increased number of cancers of the skin, colon, lung, urogenital tract, and lympho-sarcomas, the dry cleaning workers studied were also exposed to other chemicals. **Summary of Risks:** Perchloroethylene is stored in the fatty tissue and slowly metabolized with the loss of chlorine. The half-life of its urinary metabolite (trichloroacetic acid) is 144 hours. Perchloroethylene exerts the majority of its toxicity on the central nervous system causing symptoms ranging from light-headedness and slight 'inebriation' to unconsciousness. Liver damage is possible after severe acute or minor long-term exposure. It has a synergistic effect with toluene

Continue on next page

No 313 Perchloroethylene 9/92

Section 6. Health Hazard Data, continued

Medical Conditions Aggravated by Long-Term Exposure Nervous liver, kidney, or skin disorders **Target Organs:** Liver, kidney, eyes, upper respiratory tract, skin, and central nervous system **Primary Entry Routes** Inhalation and skin and eye contact **Acute Effects** Exposure to high levels can cause liver damage which may take several weeks to develop Vapor exposure can cause slight smarting of the eyes and throat (in high concentrations) In human studies, exposure to 2000 ppm/5 min caused mild CNS depression, 600 ppm/10 min caused numbness around the mouth dizziness, and incoordination, 100 ppm/7 hr caused mild eye, nose, and throat irritation, flushing of the face and neck, headache, somnolence, and slurred speech Skin contact may produce dermatitis because of perchloroethylene's defatting action (more common after repeated exposure) Direct eye contact causes tearing and burning but no permanent damage Ingestion is rare but can cause irritation of the lips, mouth and gastrointestinal tract, irregular heartbeat, nausea & vomiting, diarrhea (possibly blood stained), drowsiness, unconsciousness, and risk of pulmonary edema (fluid in lungs) **Chronic Effects** Prolonged exposure can cause impaired memory, extremity (hands, feet) weakness, peripheral neuropathies, impaired vision, muscle cramps, liver damage (fatty degeneration, necrosis, yellow jaundice, and dark urine) and kidney damage (oliguric uremia, congestion and granular swelling)

FIRST AID *Rescuers must not enter areas with potentially high perchloroethylene levels without a self-contained breathing apparatus*

Eyes Do not allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility Consult a physician immediately **Skin** Quickly remove contaminated clothing Rinse with flooding amounts of water for at least 15 min Wash exposed area with soap and water For reddened or blistered skin, consult a physician **Inhalation** Remove exposed person to fresh air and support breathing as needed *Never administer adrenalin!* **Ingestion** Never give anything by mouth to an unconscious or convulsing person Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting Be sure victim's head is positioned to avoid aspiration of vomitus into the lungs **Note to Physicians** Monitor level of consciousness, EEG (abnormalities may indicate chronic toxicity), blood enzyme levels (for 2 to 3 wk after exposure), EKG, adequacy of respirations & oxygenation, and liver and kidney function **BEIs** C_2Cl_4 in expired air (10 ppm), sample prior to last shift of work week; C_2Cl_4 in blood (1 mg/L), sample prior to last shift of work week; trichloroacetic acid in urine (7 mg/L), sample at end of workweek

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources (although noncombustible, it forms toxic vapors from thermal decomposition) For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal. For large spills, dike far ahead of spill and await reclamation or disposal Report any release in excess of 1 lb Follow applicable OSHA regulations (29 CFR 1910.120) **Environmental Transport.** If released to soil, perchloroethylene evaporates and some leaches to groundwater It may absorb slightly to soils with heavy organic matter Biodegradation may be important in anaerobic soils In water it is subject to rapid volatilization with an estimated half-life from <1 day to several weeks In air, it exists mainly in the vapor-phase and is subject to photooxidation with a half-life of 30 minutes to 2 months **Ecotoxicity Values** Guppy (*Poecilia reticulata*), LC_{50} = 18 ppm/7 days, fathead minnow (*Pimephales promelas*), LC_{50} = 18.4 mg/L/96 hr, flow through bioassay **Disposal.** Consider recovery by distillation A potential candidate for rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C) or fluidized bed incineration at 842 to 1796 °F (450 to 980 °C) Contact your supplier or a licensed contractor for detailed recommendations Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33) No U210
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4) Final Reportable
Quantity (RQ), 100 lb (45.4 kg) [* per CWA Sec 307 (a)]
SARA Extremely Hazardous Substance (40 CFR 355), TPQ Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles Wear a faceshield (8 inch minimum) per OSHA eye- and face-protection regulations (29 CFR 1910.133) Because contact lens use in industry is controversial, establish your own policy **Respirator** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator For any detectable concentration, use a supplied-air respirator or SCBA with a full facepiece operated in pressure demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA **Warning!** Air-purifying respirators do not protect workers in oxygen-deficient atmospheres If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas **Other** Wear chemically protective gloves, boots, aprons, and gauntlets made of butyl rubber, Neoprene, or Viton to prevent skin contact **Ventilation** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2) Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source ⁽¹⁰³⁾ **Safety Stations.** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities **Contaminated Equipment.** Separate contaminated work clothes from street clothes and launder before reuse Remove this material from your shoes and clean personal protective equipment **Comments** Never eat, drink, or smoke in work areas Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics

Section 9. Special Precautions and Comments

Storage Requirements Prevent physical damage to containers Store in a cool, dry well-ventilated area away from sunlight, and incompatibles Do not store sludge from vapor degreasers in tightly-sealed containers and keep outside until disposal is arranged **Engineering Controls** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level Check stabilizer levels frequently and ventilation equipment (air velocity, static pressure, air valve) at least every 3 months Install an air dryer in ventlines to storage tanks to prevent moisture from rusting and weakening the tank and contaminating or discoloring its contents Purge all tanks before entering for repairs or cleanup Build a dike around storage tanks capable of containing all the liquid Ground tanks to prevent static electricity **Administrative Controls** Consider preplacement and periodic medical exams of exposed workers that emphasize liver, kidney, and nervous system function, and the skin Alcoholism may be a predisposing factor

Transportation Data (49 CFR 172.101)

DOT Shipping Name Tetrachloroethylene
DOT Hazard Class 6.1
ID No UN1897
DOT Packing Group III
DOT Label Keep away from food
Special Provisions (172.102), N36, T1

Packaging Authorizations
a) Exceptions 173.153
b) Non-bulk Packaging 173.203
c) Bulk Packaging 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar 60 L
b) Cargo Aircraft Only 220 L
Vessel Stowage Requirements
a) Vessel Stowage A
b) Other 40

MSDS Collection References 26 73 100, 101, 103 124, 126 127, 132, 133, 140, 148, 149 153, 159 163 164, 167 168, 171, 174 175, 176, 180.

Prepared by M Gannon, BA, Industrial Hygiene Review D Wilson CIH Medical Review W Silverman, MD

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Material Safety Data Sheets Collection:

Sheet No. 312
Trichloroethylene

Issued 7/79

Revision F, 9/92

Section 1. Material Identification

Trichloroethylene (C₂HCl₃) Description Derived by treating tetrachloroethane with lime or other alkali in the presence of water, or by thermal decomposition of tetrachloroethane followed by steam distillation. Stabilizers such as epichlorohydrin, isobutanol, carbon tetrachloride, chloroform, benzene, or pentanol-2-triethanolamine are then added. Used as a degreasing solvent in electronics and dry cleaning, a chemical intermediate, a refrigerant and heat-exchange liquid, and a diluent in paint and adhesives, in oil, fat, and wax extraction and in aerospace operations (flushing liquid oxygen). Formerly used as a fumigant (food) and anesthetic (replaced due to its hazardous decomposition in closed-circuit apparatus).

Other Designations. CAS No. 79-01-6, acetylene trichloride, Algylen, Anamenth, Benzinol, Cecolene, Chlorylen, Dow-Tri, ethylene trichloride, Germalgene, Narcogen, Triasol, trichloroethene, TCE, 1,1,3-trichloroethylene.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*⁽⁷³⁾ for a suppliers list.

R 1
I 2
S 2*
K 3
* Skin absorption

NFPA



HMIS

H 2†

F 2

R 0

PPE†

† Chronic Effects

† Sec. 8

Cautions TCE is irritating and toxic to the central nervous system (CNS). Inhalation of high concentrations have lead to death due to ventricular fibrillation. Chronic exposure may lead to heart, liver, and kidney damage. The liquid is absorbed through the skin. Although it has a relatively low flash point, TCE burns with difficulty.

Section 2. Ingredients and Occupational Exposure Limits

Trichloroethylene, < 100% [contains stabilizers (Sec. 1)]

1991 OSHA PELs

8-hr TWA 50 ppm (270 mg/m³)

15-min STEL 200 ppm (1080 mg/m³)

1990 IDLH Level

1000 ppm

1990 NIOSH REL

10-hr TWA 25 ppm (~135 mg/m³)

1992-93 ACGIH TLVs

TWA 50 ppm (269 mg/m³)

STEL 200 ppm (1070 mg/m³)

1990 DFG (Germany) MAK

Ceiling 50 ppm (270 mg/m³)

Category II. Substances with systemic effects

Half-life 2 hr to shift length

Peak Exposure Limit: 250 ppm, 30 min

average value; 2 peaks/shift

1985-86 Toxicity Data*

Human, inhalation, TC_{Lo} 160 ppm/83 min caused hallucinations and distorted perceptions

Human, lymphocyte 5 mL/L caused DNA inhibition

Rabbit, skin 500 mg/24 hr caused severe irritation

Rabbit, eye 20 mg/24 hr caused moderate irritation

Mouse, oral, TD_{Lo} 455 mg/kg administered intermittently for 78 weeks produced liver tumors

* See NIOSH, RTECS (KX4550000) for additional irritation, mutation, reproductive, tumorigenic and toxicity data.

Section 3. Physical Data

Boiling Point. 189 °F (87 °C)

Freezing Point -121 °F (-85 °C)

Viscosity 0.0055 Poise at 77 °F (25 °C)

Molecular Weight. 131.38

Density 1.4649 at 20/4 °C

Refraction Index 1.477 at 68 °F (20 °C/D)

Odor Threshold 82 to 108 ppm (not an effective warning)

Vapor Pressure. 58 mm Hg at 68 °F (20 °C), 100 mm Hg at 32 °F (0 °C)

Saturated Vapor Density (Air = 0.075 lbs/ft³, 1.2 kg/m³): 0.0956 lbs/ft³, 1.53 kg/m³

Water Solubility Very slightly soluble, 0.1% at 77 °F (25 °C)

Other Solubilities Highly soluble in organic solvents (alcohol, acetone, ether, carbon tetrachloride, & chloroform) and lipids

Surface Tension. 29.3 dyne/cm

Appearance and Odor: Clear, colorless (sometimes dyed blue), mobile liquid with a sweet chloroform odor

Section 4. Fire and Explosion Data

Flash Point: 90 °F (32 °C) CC **Autoignition Temperature** 788 °F (420 °C) **LEL** 8% (25 °C); 12.5% (100 °C) **UEL** 10% (25 °C), 90% (100 °C)

Extinguishing Media. A Class 1C Flammable Liquid. Although it has a flash point of 90 °F, TCE burns with difficulty. For small fires, use dry chemical, carbon dioxide, water spray, or regular foam. For large fires, use water spray, fog, or regular foam. **Unusual Fire or Explosion Hazards** Vapor/air mixtures may explode when ignited. Container may explode in heat of fire. **Special Fire-fighting Procedures** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides only limited protection against TCE. Apply cooling water to sides of container until well after fire is out. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization TCE slowly decomposes in the presence of light and moisture to form corrosive hydrochloric acid. Hazardous polymerization cannot occur. **Chemical Incompatibilities.** Include alkalis (sodium hydroxide), chemically active metals (aluminum, beryllium, lithium, magnesium, sodium, potassium, and titanium), epoxides, and oxidants (nitrogen tetroxide, perchloric acid). Contact with 1-chloro-2,3-epoxy propane or the mono and di 2,3-epoxypropyl ethers of 1,4-butanediol + 2,2-bis-4(2',3'-epoxypropoxy)-phenylpropane can, in the presence of catalytic quantities of halide ions, cause dehydrochlorination of TCE to explosive dichloroacetylene. **Conditions to Avoid:** Exposure to light, moisture, ignition sources, and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of TCE (above 300 °C) or exposure to ultraviolet light can produce carbon dioxide (CO₂) and toxic dichloro acetylene (explosive), chlorine, hydrogen chloride, and phosgene gas.

Section 6. Health Hazard Data

Carcinogenicity. The following agencies have rated TCE's carcinogenicity: IARC (Class 3, limited animal evidence & insufficient human data), Germany MAK (Class B, justifiably suspected of having carcinogenic potential), & NIOSH (Class X, carcinogen defined with no further categorization). **Summary of Risks** TCE vapor is irritating to the eyes, nose, and respiratory tract and inhalation of high concentrations can lead to severe CNS effects such as unconsciousness, ventricular arrhythmias, and death due to cardiac arrest. Mild liver dysfunction was also seen at levels high enough to produce CNS effects. Contact with the liquid is irritating to the skin and can lead to dermatitis by defatting the skin. Chronic toxicity is observed in the victims increasing intolerance to alcohol characterized by 'degreasers flush', a transient redness of the face, trunk, and arms. The euphoric effect of TCE has led to craving and habitual snuffing of its vapors.

Continue on next page

No 312 Trichloroethylene 9/92

Section 6. Health Hazard Data, Continued

TCE crosses the placental barrier and thus exposes the fetus (any effects are yet unknown) There are increased reports of menstrual disorders in women workers and decreased libido in males at exposures high enough to cause CNS effects TCE is eliminated unchanged in expired air and as metabolites (trichloroacetic acid & trichloroethanol) in blood and urine. **Medical Conditions Aggravated by Long-Term Exposure:** Disorders of the nervous system, skin, heart, liver, and kidney. **Target Organs:** Respiratory, central & peripheral nervous, and cardiovascular (heart) systems, liver, kidney, and skin. **Primary Entry Routes:** Inhalation, skin and eye contact, and ingestion (rarely). **Acute Effects:** Vapor inhalation can cause eye, nose, and throat irritation, nausea, blurred vision, overexcitement, headache, drunkenness, memory loss, irregular heartbeat (resulting in sudden death), unconsciousness, and death due to cardiac failure. Skin contact with the liquid can cause dryness and cracking and prolonged exposure (generally if the victim is unconscious) can cause blistering. Eye contact can cause irritation and watering, with corneal epithelium injury in some cases. Ingestion of the liquid can cause lip, mouth, and gastrointestinal irritation, irregular heartbeat, nausea and vomiting, diarrhea (possibly blood-stained), drowsiness, and risk of pulmonary edema (fluid in lungs). **Chronic Effects:** Effects may persist for several weeks or months after repeated exposure. Symptoms include giddiness, irritability, headache, digestive disturbances, mental confusion, intolerance to alcohol (degreasers flush), altered color perception, loss or impairment of sense of smell, double vision, and peripheral nervous system function impairment including persistent neuritis, temporary loss of sense of touch, and paralysis of the fingers from direct contact with TCE liquid.

FIRST AID: **Eyes:** Do not allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that conscious and alert person drink 1 to 2 glasses of water, then induce vomiting. Do not give milk, as its fat content (TCE is lipid soluble) may enhance gastrointestinal absorption of TCE. **Note to Physicians:** TCE elimination seems to be triphasic with half-lives at 20 min, 3 hr, and 30 hr. Some success is seen in treating patients with propranolol, atropine, and disulfiram. Monitor urine and blood (lethal level = 3 to 110 µg/mL) metabolites. BEI = 100 mg/g creatinine (trichloroacetic acid) in urine, sample at end of workweek. BEI = 4 mg/L (trichloroethanol) in blood, sample at end of shift at end of the workweek. These tests are not 100% accurate indicators of exposure, monitor TCE in expired air as a confirmatory test.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable container for later disposal. For large spills, flush to containment area where density stratification will form a bottom TCE layer which can be pumped and containerized. Report any release in excess of 1000 lbs. Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Bluegill sunfish, $LC_{50} = 44,700 \mu\text{g/L/96 hr}$; fathead minnow (*Pimephales promelas*), $LC_{50} = 40.7 \text{ mg/L/96 hr}$. **Environmental Degradation:** In air, TCE is photooxidized with a half-life of 5 days and reported to form phosgene, dichloroacetyl chloride, and formyl chloride. In water it evaporates rapidly in minutes to hours. TCE rapidly evaporates and may leach since it does not absorb to sediment. **Soil Absorption/Mobility:** TCE has a $\log K_{oc}$ of 2, indicating high soil mobility. **Disposal:** Waste TCE can be poured on dry sand and allowed to vaporize in isolated location, purified by distillation, or returned to supplier. A potential candidate for rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C) with an acid scrubber to remove halo acids. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

SARA Extremely Hazardous Substance (40 CFR 355) Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Listed as a RCRA Hazardous Waste (40 CFR 261.33 & 261.31) No. U228 & F002 (spent solvent)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4) Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per RCRA, Sec. 3001, CWA Sec. 311 (b)(4), & CWA Sec. 307 (a)]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear chemical safety goggles (cup-type or rubber framed, equipped with impact-resistant glass), per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. At any detectable concentration, wear a SCBA with a full facepiece operated in pressure demand or other positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning!** Air-purifying respirators do not protect workers in oxygen deficient atmospheres. If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made from Viton or Neoprene to prevent skin contact. Do not use natural rubber or polyvinyl chloride (PVC). **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾ **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in steel drums, in a cool, dry, well-ventilated area away from sunlight, heat, ignition sources, and incompatibles (Sec. 5). Store large quantities in galvanized iron, black iron, or steel containers, small amounts in dark (amber) colored glass bottles. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Design processes so that the operator is not directly exposed to the solvent or its vapor. Do not use open electric heaters, high-temperature processes, arc-welding or open flames in TCE atmospheres. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers with emphasis on skin, respiratory, cardiac, central and peripheral nervous systems, and liver and kidney function. Employ air and biological monitoring (BEIs). Instruct employees on safe handling of TCE.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Trichloroethylene

DOT Hazard Class: 6.1

ID No.: UN1710

DOT Packing Group: III

DOT Label: Keep Away From Food

DOT Special Provisions: (172.102) N36 T1

Packaging Authorizations

a) Exceptions 173.153

b) Non-bulk Packaging 173.203

c) Bulk Packaging 173.241

Quantity Limitations

a) Passenger Aircraft or Railcar 60L

b) Cargo Aircraft Only 220L

Vessel Stowage Requirements

a) Vessel Stowage A

b) Other 40

MSDS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 175, 176, 180
Prepared by: M Gannon BA Industrial Hygiene Review, D Wilson CIH Medical Review, AC Darlington, MD



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Material Safety Data Sheets Collection

Sheet No. 318
Xylene (Mixed Isomers)

Issued 11/80

Revision E, 9/92

Section 1. Material Identification

39

Xylene (Mixed Isomers) (C₈H₁₀) Description The commercial product is a blend of the three isomers [*ortho*-(*o*-), *meta*-(*m*-), *para*-(*p*-)] with the largest proportion being *m*-xylene. Xylene is obtained from coal tar, toluene by transalkylation, and pseudocumene. Used in the manufacture of dyes, resins, paints, varnishes, and other organics, as a general solvent for adhesives, a cleaning agent in microscope technique, as a solvent for Canada balsam microscopy, as a fuel component; in aviation gasoline protective coatings, sterilizing catgut, hydrogen peroxide, perfumes, insect repellants, pharmaceuticals, and the leather industry, in the production of phthalic anhydride, isophthalic, and terephthalic acids and their dimethyl esters which are used in the manufacture of polyester fibers; and as an indirect food additive as a component of adhesives. Around the home, xylene is found as vehicles in paints, paint removers, degreasing cleaners, lacquers, glues and cements and as solvent/vehicles for pesticides.

Other Designations CAS No. 1330-20-7 [95-47-6, 108-38-3, 106-42-3 (*o*-, *m*-, *p*-isomers)], dimethylbenzene, methyltoluene, NCI-C55232, Violet 3, xylol.

Manufacturer Contact your supplier or distributor. Consult latest *Chemical Week Buyers Guide*⁽⁷³⁾ for a suppliers list.

Cautions Xylene is an eye, skin, and mucous membrane irritant and may be narcotic in high concentrations. It is a dangerous fire hazard.

R	1	NFPA
I	2	
S	2	
K	3	
		HMIS
		H 2+
		F 3
		R 0
		PPE ‡
		† Chronic Effects
		‡ Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Xylene (mixed isomers) the commercial product generally contains ~ 40% *m*-xylene, 20% each of *o*-xylene, *p*-xylene, and ethylbenzene, and small quantities of toluene. Unpurified xylene may contain pseudocumene.

1991 OSHA PELs

8-hr TWA. 100 ppm (435 mg/m³)
15-min STEL. 150 ppm (655 mg/m³)

1990 IDLH Level
1000 ppm

1990 NIOSH RELs

TWA. 100 ppm (435 mg/m³)
STEL. 150 ppm (655 mg/m³)

1992-93 ACGIH TLVs

TWA. 100 ppm (434 mg/m³)
STEL. 150 ppm (651 mg/m³)
BEI (Biological Exposure Index) Methylhippuric acids in urine at end of shift: 1.5 g/g creatinine

1990 DFG (Germany) MAK

TWA. 100 ppm (440 mg/m³)
Category II. Substances with systemic effects
Half-life. < 2 hr
Peak Exposure. 200 ppm, 30 min, average value, 4 peaks per shift

1985-86 Toxicity Data*

Human, inhalation, TC_{Lo} 200 ppm produced olfaction effects, conjunctiva irritation, and other changes involving the lungs, thorax, or respiration.
Man, inhalation, LC_{Lo} 10000 ppm/6 hr, toxic effects not yet reviewed.
Human, oral, LD_{Lo} 50 mg/kg, no toxic effect noted.
Rat, oral, LD₅₀ 4300 mg/kg, toxic effect not yet reviewed.
Rat, inhalation, LC₅₀ 5000 ppm/4 hr; toxic effects not yet reviewed.

* See NIOSH RTECS (XE2100000), for additional toxicity data.

Section 3. Physical Data

Boiling Point Range 279 to 284 °F (137 to 140 °C)*

Boiling Point. *ortho* 291 °F (144 °C), *meta* 281.8 °F (138.8 °C),
para 281.3 °F (138.5 °C)

Freezing Point/Melting Point *ortho* -13 °F (-25 °C),
meta -53.3 °F (-47.4 °C), *para* 55 to 57 °F (13 to 14 °C)

Vapor Pressure 6.72 mm Hg at 70 °F (21 °C)

Saturated Vapor Density (Air = 1.2 kg/m³) 1.23 kg/m³, 0.077 lbs/ft³

Appearance and Odor: Clear, sweet-smelling liquid.

* Materials with wider and narrower boiling ranges are commercially available.

Molecular Weight. 106.16

Specific Gravity 0.864 at 20 °C/4 °C

Water Solubility Practically insoluble

Other Solubilities Miscible with absolute alcohol, ether, and many other organic liquids.

Octanol/Water Partition Coefficient. logKow = 3.12-3.20

Odor Threshold 1 ppm

Viscosity <32 cSUS

Section 4. Fire and Explosion Data

Flash Point. 63 to 77 °F (17 to 25 °C) CC | Autoignition Temperature 982 °F (527 °C) (m-) | LEL 1.1 (m-, p-), 0.9 (o-) | UEL 7.0 (m-, p-), 6.7 (o-)

Extinguishing Media For small fires, use dry chemical, carbon dioxide (CO₂), water spray or regular foam. For large fires, use water spray, fog or regular foam. Water may be ineffective. Use water spray to cool fire-exposed containers. **Unusual Fire or Explosion Hazards** Xylene vapors or liquid (which floats on water) may travel to an ignition source and flash back. The heat of fire may cause containers to explode and/or produce irritating or poisonous decomposition products. Xylene may present a vapor explosion hazard indoors, outdoors, or in sewers. Accumulated static electricity may occur from vapor or liquid flow sufficient to cause ignition. **Special Fire-fighting Procedures** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing will provide limited protection. If feasible and without risk, move containers from fire area. Otherwise, cool fire-exposed containers until well after fire is extinguished. Stay clear of tank ends. Use unmanned hose holder or monitor nozzles for massive cargo fires. If impossible, withdraw from area and let fire burn. Withdraw immediately in case of any tank discoloration or rising sound from venting safety device. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization Xylene is stable at room temperature in closed containers under normal storage and handling conditions. **Hazardous polymerization** cannot occur. Xylene is easily chlorinated, sulfonated, or nitrated. **Chemical Incompatibilities** Incompatibilities include strong acids and oxidizers and 1,3-dichloro-5,5-dimethyl-2,4-imidazolidindione (dichlorohydrantoin). Xylene attacks some forms of plastics, rubber, and coatings. **Conditions to Avoid** Avoid heat and ignition sources and incompatibles. **Hazardous Products of Decomposition** Thermal oxidative decomposition of xylene can produce carbon dioxide, carbon monoxide, and various hydrocarbon products.

Section 6. Health Hazard Data

Carcinogenicity The IARC⁽¹⁶⁴⁾ NTP⁽¹⁶⁹⁾ and OSHA⁽¹⁶⁴⁾ do not list xylene as a carcinogen. **Summary of Risks** Xylene is an eye, mucous membrane, and respiratory tract irritant. Irritation starts at 200 ppm, severe breathing difficulties which may be delayed in onset can occur at high concentrations. It is a central nervous system (CNS) depressant and at high concentrations can cause coma. Kidney and liver damage can occur with xylene exposure. With prolonged or repeated cutaneous exposure, xylene produces a defatting dermatitis. Chronic toxicity is not well defined, but it is less toxic than benzene. Prior to the 1950s, benzene was often found as a contaminant of xylene and the effects attributed to xylene such as blood dyscrasias are questionable. Since the late 1950s, xylenes have been virtually benzene-free and blood dyscrasias have not been associated with xylenes. Chronic exposure to high concentrations of xylene in animal studies have demonstrated a reversible decrease in red and white cell counts as well as increases in platelet counts.

Continue on next page

No 318 Xylene (Mixed Isomers) 9/92

Section 6. Health Hazard Data, continued

Irregularity was reported in association with workplace exposure to xylene perhaps due to effects on liver metabolism. Xylene crosses the human placenta, but does not appear to be teratogenic under conditions tested to date. **Medical Conditions Aggravated by Long-Term Exposure** CNS respiratory, eye, skin, gastrointestinal (GI), liver and kidney disorders **Target Organs** CNS, eyes, GI tract, liver, kidneys, and skin **Primary Entry Routes** Inhalation, skin absorption (slight), eye contact, ingestion **Acute Effects** Inhalation of high xylene concentrations may cause dizziness, nausea, vomiting, and abdominal pain, eye, nose and throat irritation, respiratory tract irritation leading to pulmonary edema (fluid in lung), drowsiness, and unconsciousness Direct eye contact can result in conjunctivitis and corneal burns Ingestion may cause a burning sensation in the oropharynx and stomach and transient CNS depression **Chronic Effects** Repeated or prolonged skin contact may cause drying and defatting of the skin leading to dermatitis Repeated eye exposure to high vapor concentrations may cause reversible eye damage, peripheral and central neuropathy, and liver damage. Other symptoms of chronic exposure include headache, fatigue, irritability, chronic bronchitis and GI disturbances such as nausea, loss of appetite, and gas

FIRST AID *Emergency personnel should protect against exposure* **Eyes** Do not allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility Consult a physician immediately **Skin** Quickly remove contaminated clothing Rinse with flooding amounts of water for at least 15 min Wash exposed area with soap and water For reddened or blistered skin, consult a physician Carefully dispose of contaminated clothing as it may pose a fire hazard **Inhalation** Remove exposed person to fresh air and support breathing as needed Monitor exposed person for respiratory distress **Ingestion** Never give anything by mouth to an unconscious or convulsing person Contact a poison control center and unless otherwise advised, *do not induce vomiting* If spontaneous vomiting should occur, keep exposed person's head below the hips to prevent aspiration (breathing liquid xylene into the lungs) **Aspiration of a few millimeters of xylene can cause chemical pneumonitis, pulmonary edema and hemorrhage** Note to Physicians Hippuric acid or the ether glucuronide of ortho-toluic acid may be useful in diagnosis of meta-, para- and ortho-xylene exposure, respectively Consider gastric lavage if a large quantity of xylene was ingested Proceed gastric lavage with protection of the airway from aspiration, consider endotracheal intubation with inflated cuff

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and ventilate spill area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. If feasible and without undue risk, stop leak. Use appropriate foam to blanket release and suppress vapors Water spray may reduce vapor, but does not prevent ignition in closed spaces For small spills, absorb on paper and evaporate in appropriate exhaust hood or absorb with sand or some non-combustible absorbent and place in containers for later disposal For large spills dike far ahead of liquid to contain. Do not allow xylene to enter a confined space such as sewers or drains On land, dike to contain or divert to impermeable holding area. Apply water spray to control flammable vapor and remove material with pumps or vacuum equipment On water contain material with natural barriers, booms or weirs, apply universal gelling agent, and use suction hoses to remove spilled material Report any release in excess of 1000 lb Follow applicable OSHA regulations (29 CFR 1910.120) **Environmental Transport** Little bioconcentration is expected Biological oxygen demand 5 (after 5 days at 20 °C) 0.64 (no stated isomer) **Ecotoxicity values** LD₅₀ Goldfish, 13 mg/L/24 hr, conditions of bioassay not specified, no specific isomer **Environmental Degradation** In the atmosphere, xylenes degrade by reacting with photochemically produced hydroxyl radicals with a half-life ranging from 1-1.7 hr in the summer to 10-18 hr in winter or a typical loss of 67-86% per day Xylenes are resistant to hydrolysis **Soil Absorption/Mobility** Xylenes have low to moderate adsorption to soil and when spilled on land, will volatilize and leach into groundwater **Disposal** As a hydrocarbon, xylene is a good candidate for controlled incineration. Contact your supplier or a licensed contractor for detailed recommendations Follow applicable Federal, state, and local regulations

EPA Designations

SARA Extremely Hazardous Substance (40 CFR 355) Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Listed as a RCRA Hazardous Waste (40 CFR 261.33) No U239, F003 (spent solvent)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4) Final Reportable Quantity (RQ) 1000 lb (454 kg) [* per Clean Water Act, Sec 311(b)(4), per RCRA, Sec 3001]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000 Table Z-1-A)

Section 8. Special Protection Data

Goggles Wear protective eyeglasses or chemical safety goggles per OSHA eye- and face-protection regulations (29 CFR 1910.133) Because contact lens use in industry is controversial, establish your own policy **Respirator** Seek professional advice prior to respirator selection and use Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator For concentrations >1000 ppm use any chemical cartridge respirator with organic vapor cartridges, any powered, air-purifying respirator with organic vapor cartridges, any supplied-air respirator, or any self-contained breathing apparatus For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks) wear an SCBA **Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres** If respirators are used **Other** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. With breakthrough times > 8 hr, consider polyvinyl alcohol and fluorocarbon rubber (Viton) as materials for PPE **Ventilation** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec 2) Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source ⁽¹⁰³⁾ **Safety Stations** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities **Contaminated Equipment** Separate contaminated work clothes from street clothes Launder contaminated work clothing before wearing Remove this material from your shoes and clean PPE **Comments** Never eat, drink, or smoke in work areas Practice good personal hygiene after using this material, especially before eating, drinking, smoking using the toilet, or applying cosmetics

Section 9. Special Precautions and Comments

Storage Requirements Store in clearly labelled, tightly closed, containers in a cool, well-ventilated place, away from strong oxidizing materials and heat and ignition sources During transferring operations, electrically ground and bond metal containers **Engineering Controls** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level Use hermetically sealed equipment, transfer xylene in enclosed systems, avoid processes associated with open evaporating surfaces and provide sources of gas release with enclosures and local exhaust ventilation Use Class I, Group D electrical equipment. **Administrative Controls** Establish air and biological monitoring programs and evaluate regularly Consider preplacement and periodic medical examinations including a complete blood count, a routine urinalysis, and liver function tests Consider hematologic studies if there is any significant contamination of the solvent with benzene If feasible, consider the replacement of xylene by less toxic solvents such as petrol (motor fuel) or white spirit. Before carrying out maintenance and repair work, steam and flush all equipment to remove any xylene residues

Transportation Data (49 CFR 172.101)

DOT Shipping Name Xylenes

DOT Hazard Class 3

ID No. UN1307

DOT Packing Group II

DOT Label Flammable Liquid

Special Provisions (172.102) T1

Packaging Authorizations

a) Exceptions 173.150

b) Nonbulk Packaging 173.202

c) Bulk Packaging 173.242

Quantity Limitations

a) Passenger, Aircraft, or Railcar 5L

b) Cargo Aircraft Only 60L

Vessel Stowage Requirements

a) Vessel Stowage B

b) Other -

MSDS Collection References 26 73 89 100 101 103 124 126 127 132, 133 136 139 140 148 149 153 159 163 164 167 171 174 176 180

Prepared by MJ Wurth BS Industrial Hygiene Review PA Roy MPH CH Medical Review W Silverman MD

APPENDIX C
HEAT STRESS/COLD STRESS

OPERATING PROCEDURES NO. HS-201

201.0 HEAT STRESS

201.1 PURPOSE

The purpose of this Operating Procedure is to provide general information on heat stress and the methods that can be utilized to prevent or minimize the occurrence of heat stress

Adverse climatic conditions are important considerations in planning and conducting site operations. Ambient temperature effects can include physical discomfort, reduced efficiency, personal injury, and increased accident probability. Heat stress is of particular concern while wearing impermeable protective garments, since these garments inhibit evaporative body cooling.

201.2 TYPES OF HEAT STRESS

Heat stress is the combination of environmental and physical work factors that constitute the total heat load imposed on the body. The environmental factors of heat stress are the air temperature, radiant heat exchange, air movement, and water vapor pressure. Physical work contributes to the total heat stress of the job by producing metabolic heat in the body in proportion to the intensity of the work. The amount and type of clothing also affects heat stress.

Heat strain is the series of physiological responses to heat stress. When the strain is excessive for the exposed individual, a feeling of discomfort or distress may result, and, finally, a heat disorder may ensue. The severity of strain will depend not only on the magnitude of the prevailing stress, but also on the age, physical fitness, degree of acclimatization, and dehydration of the worker.

Heat disorder is a general term used to describe one or more of the heat-related disabilities or illnesses shown in Table 201-1.

201 3 METHODS OF CONTROLLING HEAT STRESS

As many of the following control measures, as appropriate, should be utilized to aid in controlling heat stress

- Provide for adequate liquids to replace lost body fluids Encourage personnel to drink more than the amount required to satisfy thirst Thirst satisfaction is not an accurate indicator of adequate salt and fluid replacement
- Replace body fluids primarily with water, with commercial mixes such as Gatorade or Quick Kick used only as a portion of the replacement fluids Avoid excessive use of caffeine drinks such as coffee, colas or tea
- Establish a work regimen that will provide adequate rest periods for cooling down The heat exposure Threshold Limit Values (TLV) may be used for guidelines
- Provide shaded work areas, if possible
- Wear cooling devices such as vortex tubes or cooling vests
- Consider adjusting work hours to avoid the worst heat of the day
- Take breaks in a cool rest area
- Remove any impermeable protective garments during rest periods
- Do not assign other tasks to personnel during rest periods
- Inform personnel of the importance of adequate rest, acclimation, and proper diet in the prevention of heat stress

201.6 MONITORING

201 6.1 Temperature

The environmental heat stress of an area can be monitored by the Wet Bulb Globe Temperature Index (WBGT) technique. When heat stress is a possibility, a heat stress monitoring device, such as the Wibget Heat Stress Monitor (Reuter Stokes) can be utilized.

The WBGT shall be compared to the TLV outlined by the American Conference of Governmental Industrial Hygienists (ACGIH) TLV guides, and a work-rest regimen can be established in accordance with the WBGT. Note that approximately 5°C must be subtracted from the TLVs listed for heat stress to compensate for the wearing of impermeable protective clothing.

201 6.2 Medical

In addition to the provisions of the Woodward-Clyde (W-C) medical surveillance program, on-site medical monitoring of personnel should be performed for projects where heat stress is a significant concern. Blood pressure, pulse, body temperature (oral), and body weight loss may be utilized.

Heart Rate: Count the radial pulse during a 30-second period as early as possible in the rest period. If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third. If the heart rate still exceeds 110 beats per minute at the next rest cycle, shorten the following work cycle by one-third.

Oral Temperature: Use a clinical thermometer or similar device to measure the oral temperature at the end of the work period (before drinking liquids). If the oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period. If the oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by one-third.

Do not permit a worker to wear a semipermeable or impermeable garment if his/her oral temperature exceeds 100.6°F (38.1°C).

Body Water Loss: Measure body weight on a scale accurate to ± 0.25 pounds at the beginning and end of each work day (also at lunch break, if possible) to see if enough fluids are being taken to prevent dehydration. Weights should be taken while the employee wears similar clothing or, ideally, nude. The body water loss should not exceed 1.5 percent total body weight loss in a work day.

Physiological Monitoring Initially, the frequency of physiological monitoring depends on the air temperature adjusted for solar radiation and the level of physical work. The length of the work cycle will be governed by the frequency of the required physiological monitoring.

201.7 REFERENCES

American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents, 1992-1993

EPA, Standard Operating Safety Guides, 1992, Pages 91-93

National Institute for occupational Safety and Health, Criteria for a Recommended Standard Occupational Exposure to Hot Environments, 1986

TABLE 201-1

Classification, Medical Aspects, and Prevention of Heat Illness

Category and Clinical Features	Predisposing Factors	Underlying Physiological Disturbances	Treatment	Prevention
Temperature Regulation Heatstroke Heatstroke (1) Hot, dry skin, usually red, mottled, or cyanotic, (2) rectal temperature 40 5°C (104°F) and over (3) confusion loss of consciousness convulsions rectal temperature continues to rise, fatal if treatment is delayed	(1) Sustained exertion in heat by unacclimatized workers, (2) lack of physical fitness and obesity, (3) recent alcohol intake, (4) dehydration, (5) individual susceptibility, and (6) chronic cardiovascular disease	Failure of the central drive for sweating (cause unknown) leading to loss of evaporative cooling and an uncontrolled accelerating rise in t_{re} , there may be partial rather than complete failure of sweating	Immediate and rapid cooling by immersion in chilled water with massage or by wrapping in wet sheet with vigorous fanning with cool dry air, avoid overcooling, treat shock if present	Medical screening of workers, selection based on health and physical fitness acclimatization for 5-7 days by graded work and heat exposure, <i>monitoring</i> workers during sustained work in severe heat
Circulatory Hypostasis Heat Syncope Fainting while standing erect and immobile in heat	Lack of acclimatization	Pooling of blood in dilated vessels of skin and lower parts of body	Remove to cooler area, rest in recumbent position, recovery prompt and complete	Acclimatization, intermittent activity to assist venous return to heat
Water and or Salt Depletion (a) <u>Heat Exhaustion</u> (1) Fatigue, nausea, headache giddiness (2) skin clammy and moist, complexion pale, muddy, or hectic flush, (3) may faint on standing with rapid thready pulse and low blood pressure, (4) oral temperature normal or low but rectal temperature usually elevated (37.5-38.5°C or 99.5-101.3°F), water restriction type urine volume small, highly concentrated, salt restriction type, urine less concentrated chlorides less than 3 g/L (b) <u>Heat Cramps</u> Painful spasms of muscles used during work (arms legs or abdominal) onset during or after work hours	(1) Sustained exertion in heat, (2) lack of acclimatization and (3) failure to replace water lost in sweat (1) Heavy sweating during hot work, (2) drinking large volumes of water without replacing salt loss	(1) Dehydration from deficiency of water, (2) depletion of circulating blood volume, (3) circulatory strain from competing demands for blood flow to skin and to active muscles Loss of body salt in sweat, water intake dilutes electrolytes, water enters muscles, causing spasm	Remove to cooler environment, rest in recumbent position, administer fluids by mouth, keep at rest until urine volume indicates that water balances have been restored Salted liquids by mouth or more prompt relief by IV infusion	Acclimatize workers using a breaking in schedule for 5-7 days, supplement dietary salt only during acclimatization, ample drinking water to be available at all times and to be taken frequently during work day Adequate salt intake with meals for unacclimatized workers, supplement salt intake at meals

TABLE 201-1 (continued)
Classification, Medical Aspects, and Prevention of Heat Illness

Category and Clinical Features	Predisposing Factors	Underlying Physiological Disturbances	Treatment	Prevention
Skin Eruptions (a) <u>Heat Rash</u> (miliaria rubra, or "prickly heat") Profuse tiny raised red vesicles (blisterlike) on affected areas, prickling sensations during heat exposure (b) <u>Anhidrotic Heat Exhaustion</u> (miliaria profunda) Extensive areas of skin which do not sweat on heat exposure, but present gooseflesh appearance, which subsides with cool environments, associated with incapacitation in heat	Unrelieved exposure to humid heat with skin continuously wet from unevaporated sweat Weeks or months of constant exposure to climatic heat with previous history of extensive heat rash and sunburn	Plugging of sweat gland ducts with sweat retention and inflammatory reaction Skin trauma (heat rash, sunburn) causes sweat retention deep in skin reduced evaporative cooling causes heat intolerance	Mild drying lotions, skin cleanliness to prevent infection No effective treatment available for anhidrotic areas of skin, recovery of sweating occurs gradually on return to cooler climate	Cool sleeping quarters to allow skin to dry between heat exposures Treat heat rash and avoid further skin trauma by sunburn, provide periodic relief from sustained heat
Behavioral Disorders (a) <u>Heat Fatigue - Transient</u> Impaired performance of skilled sensorimotor mental, or vigilance tasks, in heat (b) <u>Heat Fatigue - Chronic</u> Reduced performance capacity, lowering of self-imposed standards of social behavior (e g alcoholic over-indulgence), inability to concentrate, etc	Performance decrement greater in unacclimatized and unskilled worker Workers at risk come from temperature climates for long residence in tropical latitudes	Discomfort and physiologic strain Psychosocial stresses probably as important as heat stress may involve hormonal imbalance but no positive evidence	Not indicated unless accompanied by other heat illness Medical treatment for serious causes, speedy relief of symptoms on returning home	Acclimatization and training for work in the heat Orientation on life in hot regions (customs, climate, living conditions etc)

TABLE 201-2
PERMISSIBLE HEAT EXPOSURE THRESHOLD LIMIT VALUES
ADAPTED FROM THE ACGIH 1992-1993 TLVs

Level of PPE	Work-Rest Regimen each hour	Work Load in WBGT ^(a)					
		Light ^(b)		Moderate ^(c)		Heavy ^(d)	
		°C	°F	°C	°F	°C	°F
Summer Work Uniform	Continuous Work	30.0	86	26.7	80	25.0	77
	75% Work / 25% Rest	30.6	87	28.0	82	25.9	78
	50% Work / 50% Rest	31.4	89	29.4	85	27.9	82
	25% Work / 75% Rest	32.2	90	31.1	88	30.0	86
D (Cotton Coveralls)	Continuous Work	28.0	82	24.7	77	23.0	73
	75% Work / 25% Rest	28.6	84	26.0	79	23.9	75
	50% Work / 50% Rest	29.4	85	27.4	81	25.9	77
	25% Work / 75% Rest	30.2	87	29.1	84	28	82
C (Water barrier, permeable)	Continuous Work	24.0	75	20.7	69	19.0	66
	75% Work / 25% Rest	24.6	76	22.0	72	19.9	68
	50% Work / 50% Rest	25.4	78	23.4	74	21.9	71
	25% Work / 75% Rest	26.2	79	25.1	77	24.0	75
B (Water barrier, impermeable)	Continuous Work	20.0	68	16.7	62	15.0	59
	75% Work / 25% Rest	20.6	69	18.0	64	15.9	61
	50% Work / 50% Rest	21.4	71	19.0	66	17.9	64
	25% Work / 75% Rest	22.2	72	21.0	70	20.0	68

(a) For unacclimatized workers, the permissible heat exposure TLV should be reduced by 2.5% °C

(b) Light = sitting or standing to control machinery, performing light hand or arm work

(c) Moderate = walking about with moderate lifting or pushing

(d) Heavy = pick and shovel work, hand auguring

OPERATING PROCEDURE NO. HS-202

202.0 COLD STRESS

202.1 PURPOSE

The purpose of this Operating Procedure is to provide information on cold stress and the procedures for preventing and dealing with cold stress. Adverse climatic conditions are important considerations in planning and conducting site operations. Ambient temperature effects can include physical discomfort, reduced efficiency, personal injury, and increased accident probability.

202.2 TYPES OF COLD STRESS EFFECTS

202.2.1 Frostbite

Local injury resulting from cold is included in the generic term frostbite. There are several degrees of damage. Frostbite can be categorized into

- **Frost Nip or Initial Frostbite:** (1st degree frostbite) Characterized by blanching or whitening of skin.
- **Superficial Frostbite:** (2nd degree frostbite) Skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient. Blistering and peeling of the frozen skin will follow exposure.
- **Deep Frostbite:** (3rd degree frostbite) Tissues are cold, pale, and solid, extremely serious injury with possible amputation of affected area.

Frostbite can occur without hypothermia when the extremities do not receive sufficient heat. The toes, fingers, cheeks, and ears are the most commonly affected. Frostbite occurs when there is freezing of the fluids around the cells of the affected tissues. The first symptom of frostbite is an uncomfortable sensation of coldness, followed by numbness. There may be tingling, stinging, or cramping. Contact by the skin with tools or other metal objects below 20°F (-7°C) may result in contact frostbite.

The prevention of frostbite includes early recognition of problems, adequate protective clothing, recognizing the combination of wind and low temperature (see Table 202-1 Windchill Index), adequate fluids, work-rest regimens with heated rest areas, and use of controls such as wind-breaks and heaters

The initial treatment for frostbite includes bringing the individual to a warm location, removal of clothing in the affected area, and placing the affected parts in warm (100-105°F) water. Do not massage or rub the frostbite area. After the initial treatment, wrap the affected area loosely in sterile gauze and seek medical attention.

202.2.2 Hypothermia

Hypothermia results when the body loses heat faster than it can be produced. When this situation first occurs, blood vessels in the skin constrict in an attempt to conserve vital internal heat. Hands and feet are first affected. If the body continues to lose heat, involuntary shivers begin. This is the body's way of attempting to produce more heat, and it is usually the first real warning sign of hypothermia. Further heat loss produces speech difficulty, confusion, loss of manual dexterity, collapse, and finally death. Wet clothes or immersion in cold water greatly increases the hypothermia risk. The progressive clinical presentation of hypothermia may be seen in Table 202-2.

Prevention of hypothermia includes planning for outside work in winter conditions, particularly work over water. Planning will include adequate layers of clothing, training employees in recognizing hypothermia in themselves and others, recognition of the combination of wind and temperature (see Windchill Index in Table 202-1), use of controls such as wind-breaks and heaters, a work-rest schedule, and adequate fluid intake.

Fatal exposure to cold among workers has usually resulted from immersion in low temperature water. Water transmits body heat over 200 times faster than air. Wetsuits or drysuits are recommended for work over water with water temperatures below 45°F. Individuals who fall into cold water without wetsuits or drysuits may not be able to swim due to the rapid onset of hypothermia.

Prompt treatment of hypothermia is essential. Once the body temperature drops below 95°F, the loss of temperature control occurs, and the body can no longer rewarm itself. Initial treatment includes reducing heat loss by moving the individual out of the wind and cold, removal of wet clothing, applying external heat (such as a pre-warmed sleeping bag, electric blanket, or body-heat from other workers) and follow-up medical attention.

202.4 EXPOSURE LIMITS

The American Conference of Governmental Industrial Hygienists (ACGIH) has adopted Threshold Limit Values (TLVs) for cold stress. These limits set maximum work periods based on a combination of wind and temperature.

202.5 REFERENCES

American Conference of Governmental Industrial Hygienists, Documentation of Threshold Limit Values, 1984

EPA, Standard Operating Safety Guides, 1992, pages 95-100

TABLE 202-1

Windchill Index¹

		ACTUAL THERMOMETER READING (°F)										
		50	40	30	20	10	0	-10	-20	-30	-40	
		EQUIVALENT TEMPERATURE (F)										
Wind speed in mph		50	40	30	20	10	0	-10	-20	-30	-40	
calm		50	40	30	20	10	0	-10	-20	-30	-40	
5		48	37	27	16	6	-5	-15	-26	-36	-47	
10		40	28	16	4	-9	-21	-33	-46	-58	-70	
15		36	22	9	-5	-18	-36	-45	-58	-72	-85	
20		32	18	4	-10	-25	-39	-53	-67	-82	-96	
25		30	16	0	-15	-29	-44	-59	-74	-88	-104	
30		28	13	-2	-18	-33	-48	-63	-79	-94	-109	
35		27	11	-4	-20	-35	-49	-67	-82	-98	-113	
40		26	10	-6	-21	-37	-53	-69	-85	-100	-116	
Over 40 mph (little added effect)		Little Danger (for properly clothed person)					Increasing Danger (Danger from freezing of exposed flesh)					Great Danger

¹ Source Fundamentals of Industrial Hygiene, Third Edition Plog, B A , Benjamin, G S , Kerwin, M A , National Safety Council, 1988

TABLE 202-2

Progressive Clinical Presentations of Hypothermia*

<u>Core Temperature</u>		
°C	°F	Clinical Signs
37.6	99.6	"Normal" rectal temperature
37	98.6	"Normal" oral temperature
36	96.8	Metabolic rate increases in an attempt to compensate for heat loss
35	95.0	Maximum shivering
34	93.2	Victim conscious and responsive, with normal blood pressure
33	91.4	Severe hypothermia below this temperature
32	89.6	Consciousness clouded, blood pressure becomes difficult to obtain, pupils dilated but react to light, shivering ceases
31	87.8	
30	86.0	Progressive loss of consciousness, muscular rigidity increases, pulse and blood pressure difficult to obtain, respiratory rate decreases
29	84.2	
27	82.4	Ventricular fibrillation possible with myocardial irritability
27	80.6	Voluntary motion ceases, pupils nonreactive to light, deep tendon and superficial reflexes absent
26	78.8	Ventricular fibrillation may occur spontaneously
25	77.0	
24	75.2	Pulmonary edema
22	71.6	Maximum risk of ventricular fibrillation
21	69.8	
20	68.0	Cardiac standstill
18	64.4	Lowest accidental hypothermia victim to recover
17	62.6	Isoelectric electroencephalogram
9	48.2	Lowest artificially cooled hypothermia patient to recover

* Presentations approximately related to core temperature. Reprinted from the January 1982 issue of American Family Physician, published by the American Academy of Family Physicians

APPENDIX D
TICKS AND TICKBORNE DISEASES

OPERATING PROCEDURE NO. HS-213

213.0 TICKS AND TICK-BORNE DISEASES

213.1 PURPOSE

The purpose of this Operating Procedure (OP) is to provide information to Woodward-Clyde (W-C) employees regarding the diseases transmitted by ticks, particularly Lyme disease, and how to reduce employee risk

213.2 TICK-BORNE DISEASES

Tick-borne diseases represent a significant health risk in many parts of the world. The risk to W-C field staff depends on the work location, the time of year, the clothing worn and other factors. Ticks are documented vectors of virus and bacteria for diseases such as Lyme disease (North America, Europe), Rocky Mountain Spotted Fever (North America), Encephalitis (Asia, Africa), Boutonneuse Fever (Africa, India, Middle East), and Rickettsiosis (Asia).

While specific information in this OP is limited to Lyme disease, the risk control measures apply to other tick-borne diseases.

213.3 LYME DISEASE

Lyme disease is caused by a coiled bacteria known as a spirochete and is most commonly transferred to humans through ticks. The disease has been found in almost all U.S. states and in Europe, but is most common in locations with a mixture of wooded areas and grasslands. The Lyme disease infection is spread in the wild by tick bites on animals, particularly mice and deer, and infection can include domestic animals such as cats, dogs, and cows. While a number of ticks can transfer Lyme disease, the very small deer tick is the most common.

The tick bite is usually not painful and because of the small size of the deer tick, is often not noticed. In most cases, the tick simply draws blood for its nourishment and after a few days drops off. If the tick is infected with the Lyme disease bacteria, it may be transmitted during this feeding process.

213.3.1 Lyme Disease Symptoms

A typical early symptom of infection is a slowly expanding red rash. The rash often starts as a flat or raised red area and slowly expands after several days, with partial central clearing, resulting in a red ring appearance. While most people will develop an observable red rash, some Lyme disease victims may lack this symptom.

Other common early symptoms of Lyme disease include fatigue, headache, muscle aches, neck stiffness, fever, and swollen glands.

Later symptoms, if untreated, include joint pain and swelling, nervous system problems, heart complications, and other effects. These later symptoms usually occur one to four months after the original infection and can result in permanent health effects.

213.3.2 Lyme Disease Treatment

Lyme disease is easily treated by use of antibiotics when detected early. Individuals that develop a rash or experience other early symptoms of Lyme disease should promptly see a physician for treatment. Although the disease is more difficult to treat if further advanced, it is still treatable using larger antibiotic (usually intravenous) doses.

213.3.3 Reducing Lyme Disease Risk

Field personnel can reduce the risk of tick-borne diseases through proper clothing, use of repellents, use of good work practices, and recognizing early symptoms.

Field personnel in grassy or wooded areas should wear long pants, long sleeved shirts (tucked in), hat, and consider taping or cinching clothing at the ankles. Work in areas of known high tick concentrations (e.g., wetland areas) should consider use of Tyvek coveralls taped at the ankles and wrists.

Follow label directions carefully for use of tick repellents as many are designed for use on clothing, not on skin. Repellent use should be in combination with proper clothing and is most recommended for the ankles and wrists.

After working in an area of possible tick exposure, it is recommended that the individual shower promptly and check for any ticks. If a tick is found on the skin, remove it promptly using tweezers or forceps, followed by disinfection with alcohol or iodine. It takes several hours for a tick to attach and feed, removing it promptly lessens the chance of being infected.

APPENDIX E
SAFETY COMPLETION REPORT

SAFETY COMPLETION REPORT

(This report must be submitted to the Corporate Health and Safety Officer within five days after completion of the project)

Report Completed By _____ Date Completed _____

Project Name _____

Project Number _____

1 Evaluation of Health and Safety Plan (Add a page if additional space is needed)

- a Was the plan adequate? _____
- b Did the plan adequately anticipate chemical and physical hazards actually present at the site?

- c What situations were discovered that were not anticipated in the health and safety plan?

- d How were these situations handled? _____

- e Was the recommended personal protective equipment, such as gloves, respirators, eye, face and whole body skin protection appropriate to protect employees from chemical hazards? _____
- f If not, what should be improved in future plans of this type? _____

2 Exposure Data

- a Were any employees exposed to chemical or physical hazards as a result of failure of personal protective equipment or other problem? _____ If yes, give names of employees

- b Was monitoring performed? _____
- c What type of monitoring?
_____ area monitoring
_____ personal (on-employee) monitoring

d What type of monitoring equipment was used?

- ☐ personal air sampling pumps
- ☐ colorimetric indicator ("Draeger") tubes
- ☐ vapor badges
- ☐ film badges or TLD badges (radiation)
- ☐ charcoal sorbent tube samples

direct reading instruments, including

- ☐ PID
- ☐ HNU
- ☐ OVA
- ☐ Combustible gas
- ☐ Oxygen deficiency
- ☐ Hydrogen Sulfide
- ☐ Carbon monoxide

e Summary of Sampling Results (Attach additional pages if more space is needed)

(Report here the air quality sampling results, sampling locations, work activities during sampling, documentation of instrument calibration, weather conditions during sampling, and sampling frequency Report should minimally contain a summary of all sampling completed within the breathing zone)

APPENDIX F
CALIBRATION RECORDS

COMBUSTIBLE GAS INDICATOR CALIBRATION RECORD

INSTRUMENT

MODEL NUMBER

SERIAL NUMBER

CAL GAS & LOT NO

[illegible]

NOTE CAL - Calibration LEL - Lower Explosive Limit

ORGANIC VAPOR DETECTOR CALIBRATION RECORD

INSTRUMENT

MODEL NUMBER

SERIAL NUMBER

LAMP TYPE

CAL GAS & LOT NO

[illegible]

NOTE CAL - Calibration

EQUIPMENT LIST

The following is a list of equipment that may be needed to perform personal air monitoring

- Gillian, MSA, or equivalent personal sampling pumps
- Media Specified by the NIOSH method, and if necessary confirmed with the analytical laboratory
- Tygon tubing (1/4" ID)
- Sample coolers
- Shipping boxes
- Packing material
- All weather field book
- Belts (for mounting and carrying sample pumps)
- Adjustable flow manifolds
- Bubble meter or calibration instrument (e g , Gillibrator)
- Stopwatch
- Wristwatches
- Dish soap
- Tap water
- Ice (blue ice)
- Small bowl
- Rotometers
- Clips
- Pocket knife
- Cassette adaptors
- Personal health and safety equipment, as described in the Health and Safety Plan
- Air monitoring data sheets

PUMP CALIBRATION

The flow rate will be set by adjusting the sampling pump If very low sampling rates are needed, the personal sampling pump can be placed in the low-flow mode and the flow rate manifolds adjusted to achieve the appropriate flow rate

Flow rates will be set with a calibration media in line. The calibration media will be taken from the same lot as media used for sampling. Calibration of flow rates may be accomplished by use of a primary standard such as a bubble meter or Gillibrator, or accomplished by use of a rotometer calibrated by reference to a primary standard.

Flow rates for one hour samples will be checked at the beginning and end of the sample period. Flow rates for full shift samples will be calibrated at the beginning and every two hours during the sample period. If flow rates vary more than 15 percent from the target flow rate the sample will be considered invalid. Flow rates recorded during sampling will be averaged and used to determine the total sample volume. Flow rates will be recorded on flow rate check sheets (Figure H-1).

SAMPLE COLLECTION

Samples will be collected from the breathing zone of the worker considered to have the greatest exposure or potential for exposure at the site. The sampling pump will typically be attached to the worker's belt with tubing threading to the outside of the worker's clothing. The sample will be collected from the breathing zone of the worker, defined as the area within 1 foot of the face on the front of the body. Sorbent tubes (if used) will be oriented vertically if possible.

As much as possible, sampling will be limited to periods of time when the worker is involved with site construction, inspection or sampling activities. Start time and stop times will be recorded for all sampling.

FIELD BLANKS AND QUALITY CONTROL SAMPLES

For each group of samples taken in a day, a field blank will be prepared by exposing the collection media in the field and sealing it immediately. The field blank will be labeled, stored, shipped, and analyzed with and under the same conditions as other samples collected that day. The samples will be shipped as a blind sample (not identified as a blank).

SAMPLE STORAGE AND SHIPPING

Samples will be stored and handled as specified in the NIOSH methods. Samples will be shipped, preserved on blue ice where appropriate, using proper chain-of custody procedures. The laboratory will be notified before shipment.

FIELD NOTES

Documentation of observations and data acquired in the field will provide information on the proper acquisition of samples and also provide a permanent record. These observations will be recorded in a field book or personnel monitoring data sheets. The information will include at least the following:

- Sampler's name
- Date and start and stop times of sample collection
- Calibration method used and serial number of bubble flow meter or rotometer
- Worker's name
- Worker's activities and working conditions
- Sample identification number

NONCONFORMANCES AND CORRECTIVE ACTION

A nonconformance is defined as a deficiency or improper procedure which renders the quality of an item unacceptable or indeterminant.

Corrective actions may include enhancing required documentation or possibly resampling after the sampling pump has been recalibrated.

FIGURE 1
AIR MONITORING SAMPLE INFORMATION

PROJECT

SITE

LOCATION

INDIVIDUAL SAMPLED

CONTAMINANTS FOR ANALYSIS

SAMPLE LOCATION

SAMPLE MEDIA

MEDIA LOT NUMBER

DATE SAMPLED

PUMP MODEL NO

TIME SAMPLED

PUMP SERIAL NO

OPERATOR

CALIBRATED FLOW RATE

SAMPLE NO

START TIME

STOP TIME

Time	Calibrated Flow Rate	Flowmeter Reading	Ambient Temperature	Barometric Pressure	Relative Humidity	Comments
1						
2						
3						
4						
5						

Notes

**ADDENDUM #1 TO THE TRENCHES AND MOUND SITE CHARACTERIZATION
HEALTH AND SAFETY PLAN, OPERABLE UNIT 2
February, 1995, Document No. RF/ER-95-011**

**RESAMPLING SUBSURFACE SOILS AND SOIL GAS
AT OPERABLE UNIT 2
TRENCH 2, INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) 109
July and August, 1995**

In March, 1995, subsurface soil samples were taken at Trench 2, Individual Hazardous Substance Site (IHSS) 109. Resampling of this area is necessary to support accelerated remediation of the IHSS. The original Health and Safety Plan (HASP), Trenches and Mound Site Characterization Health and Safety Plan, Operable Unit 2, dated February, 1995, written and implemented by Woodward-Clyde, will be used as the base document for the resampling effort. This addendum contains the necessary project-specific changes.

This addendum is organized so that the numbered subsections correspond to those in the original HASP. All subsections not listed in this addendum will be used as they appear in the original HASP.

This addendum covers only the resampling effort at Trench 2, IHSS 109. It is effective until December, 1995.

2 0 INTRODUCTION

(Substitute the following section for the Introduction found in the original HASP)

Prior to initiating field activities, all personnel who will be entering the exclusion zone (EZ) or contamination reduction zone (CRZ), must review the original HASP for this project as well as this addendum. All such personnel will be briefed on the contents of these two health and safety documents, and will be required to abide by the provisions set forth in the documents. Before entering the project site, project personnel must sign the Compliance Agreement forms in Appendix A. Project visitors to the CRZ or EZ have the same requirements for site entry as project personnel. In addition, visitors to the EZ must be escorted by a member of the field team at all times.

Changes to this addendum can be made with the approval of the RMRS (Rocky Mountain Remediation Services) Project Manager, RMRS Radiological Engineer, and RMRS Health and Safety Supervisor.

3 0 PROJECT PERSONNEL

(Substitute the following section for Section 3 0 of the original HASP)

The responsibilities and authorities of each individual, relating to health and safety issues, are presented in Table 3-1. A project phone list is presented in Table 3-2. A project organization chart is included as Figure 3-1.

TABLE 3-1
HEALTH AND SAFETY RELATED RESPONSIBILITIES AND AUTHORITIES

PERSON	RESPONSIBILITIES	AUTHORITIES
<p>RMRS Project Manager</p> <p>Robin Volk</p>	<p>Ensure that the project is performed in a manner consistent with this HASP and Addendum, and to the Health and Safety Practices (HSP) manual</p> <p>Provide project personnel with the resources they need to fully implement project health and safety</p> <p>Report any injuries, accidents or near miss accidents to the RMRS Health and Safety Supervisor</p> <p>Ensure that this Addendum is properly prepared, implemented, and approved</p> <p>Approve any changes to this addendum</p>	<p>Suspend field activities if health and safety of personnel are endangered</p> <p>Suspend a member of the project team from field activities for infractions of the HASP and Amendment, or for jeopardizing the health and safety of themselves or another team member</p>

PERSON	RESPONSIBILITIES	AUTHORITIES
Kaiser-Hill Radiological Engineer	Ensure that proper radiological controls are in place for the project	Suspend field activities if health and safety of personnel are endangered
Rick Gentry (Alternate - Jerry Anderson)	Maintain communication with the Health and Safety Specialist regarding radiological issues and make changes to project procedures if necessary Generate any required Radiation Work Permits (RWP) needed for the project Approve any changes to this amendment	Determine the radiological controls needed for the project

PERSON	RESPONSIBILITIES	AUTHORITIES
<p>RMRS Health and Safety Supervisor</p> <p>Peggy Schreckengast</p>	<p>Ensure that the project is performed in a manner consistent with this HASP and Addendum, and to the Health and Safety Practices (HSP) manual</p> <p>Provide support to Project Manager and Health and Safety Specialist with any health and safety needs</p> <p>Conduct weekly inspections of the work site to identify hazards and non-compliance to the HASP</p> <p>Keep records of weekly inspections</p> <p>Pursue corrections of hazards which fall outside the project scope</p> <p>Track status of all hazards for which corrective actions are not immediate</p> <p>Review certifications and medical surveillance status of all non-RTG personnel prior to site access</p> <p>Maintain these health and safety records on site</p> <p>Ensure that this Addendum is properly prepared, implemented, and approved</p> <p>Approve any changes to this addendum</p>	<p>Suspend field activities if health and safety of personnel are endangered</p> <p>Determine, with concurrence of the Health and Safety Specialist, the health and safety requirements for this project</p>

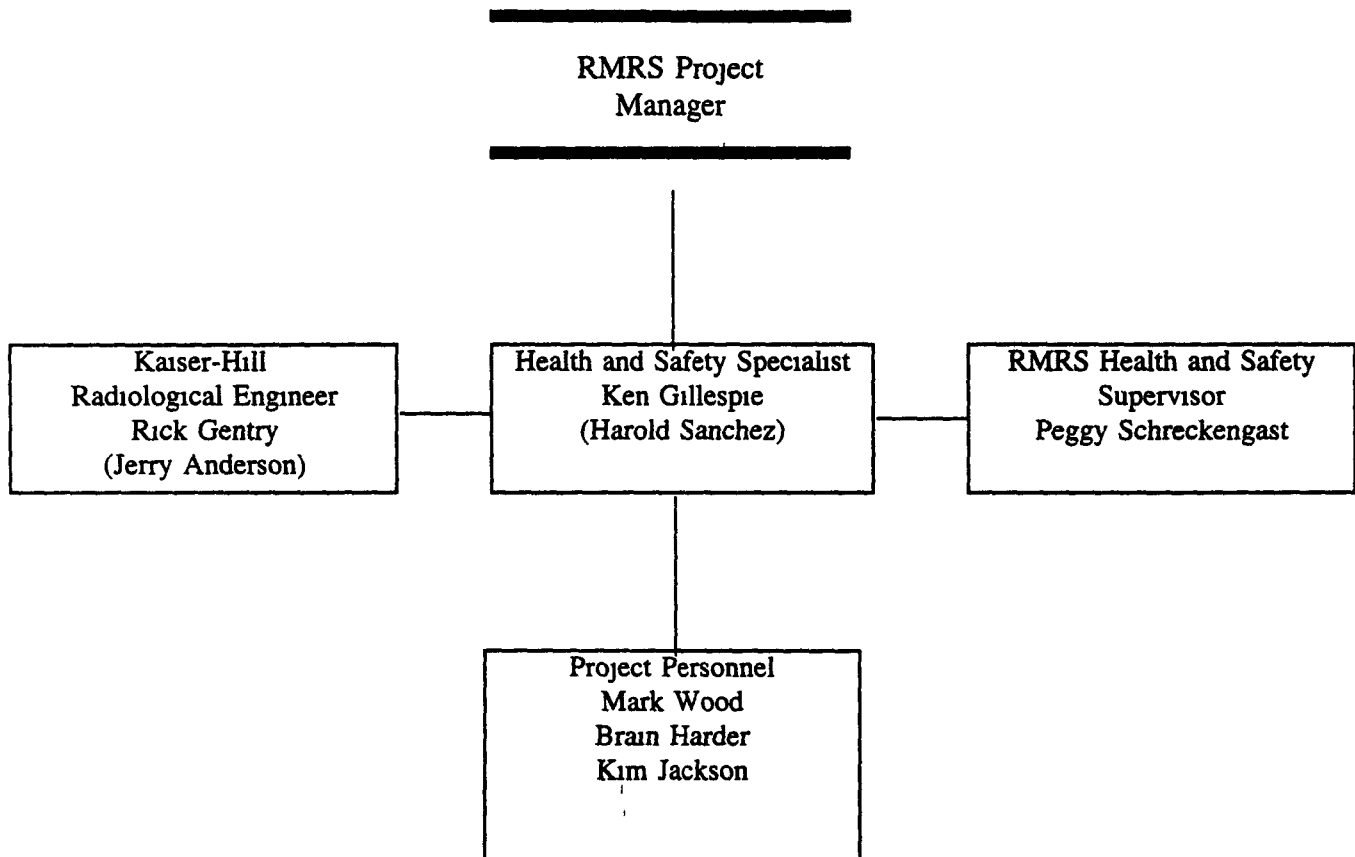
PERSON	RESPONSIBILITIES	AUTHORITIES
<p>Health and Safety Specialist</p> <p>Ken Gillespie (Assisted by Harold Sanchez)</p>	<p>Ensure that the project is performed in a manner consistent with this HASP and Addendum, and to the Health and Safety Practices (HSP) manual</p> <p>Direct health and safety activities on site</p> <p>Conduct required health and safety monitoring</p> <p>Maintain health and safety equipment on site</p> <p>Conduct daily inspections of the work site to identify hazards and non-compliance to the HASP</p> <p>Keep records of daily inspections and any corrective actions taken</p> <p>Implement emergency procedures as required</p> <p>report all injuries, illnesses and near-miss accidents to the RMRS Health and safety Supervisor</p> <p>review certifications/medical surveillance status of all RTG personnel prior to site access</p> <p>maintain these RTG health and safety records on site</p>	<p>Suspend field activities if health and safety of personnel are endangered</p> <p>Suspend a member of the project team from field activities for infractions of the HASP and Amendment, or for jeopardizing the health and safety of themselves or another team member</p>

PERSON	RESPONSIBILITIES	AUTHORITIES
Project Personnel Brian Harder Kim Jackson Mark Wood	Ensure that the project is performed in a manner consistent with this HASP and Addendum, and to the Health and Safety Practices (HSP) manual Comply with the provisions set forth in this HASP and addendum Report any health and safety issues or problems to the Health and Safety Specialist Report any injuries, illnesses, or near-miss accidents to the Health and safety Specialist Conduct work in a safe manner	

**TABLE 3-2
PROJECT PHONE LIST**

Name	Title	Work Number	Pager Number
Robin Volk	RMRS Project Manager	8645	6145
Tim Lovseth	RMRS Assistant Project Manager	8706	5134
Rick Gentry	Kaiser-Hill Radiological Engineer	8349	3521
Jerry Anderson	Kaiser-Hill Radiological Engineer	6974	7336
Peggy Schreckengast	RMRS Health and safety Supervisor	6790	3059
Ken Gillespie	Health and Safety Specialist	5356	NA
Harold Sanchez	Health and Safety Specialist	6079	NA
Mark Wood	RMRS Geologist	8784	5904
Brian Harder	Sampling Equipment Operator	4953	NA
Kim Jackson	Sampling Equipment Operator	4953	NA

FIGURE 3-1
HEALTH AND SAFETY RELATED PROJECT ORGANIZATION



5 0 SCOPE OF WORK

Only tasks 3, 4, and 5 will be conducted during this resampling effort

6 1 1 Volatile Organic Compounds (VOCs)

At Trench 2, VOCs are the main chemical hazards. The following VOCs are present in Trench 2 at levels which may contribute to personal exposure

- PCE (refer to HASP for information),
 - 1,2-DCA (refer to HASP for information),
 - TCE (refer to HASP for information),
 - Xylenes (refer to HASP for information),
 - 1,1,1-TCA (refer to HASP for information),
 - Ethyl benzene,
 - 1,2-DCE,
 - Toluene, and
 - 4-methyl - 2-pentanone
-
- Ethyl benzene is a colorless solvent with a pungent odor. It is used in the production of automotive fuels and other chemicals. Symptoms of overexposure include irritation of the eyes, skin, and respiratory tract, headaches, drowsiness, and dizziness. Ethyl benzene targets the eyes, skin, respiratory system, and CNS.
 - 1,2-DCE was used as a solvent and studied as an anesthetic. It is highly flammable. Symptoms of overexposure include irritation of the eyes and respiratory system, and depression of the CNS, which results in dizziness, fatigue, and light headedness. 1,2-DCE targets the eyes, respiratory system, and CNS.
 - Toluene is a widely used solvent. It is a clear, flammable liquid with a sweet, pungent odor. Symptoms of overexposure include irritation of the eyes and nose, fatigue, weakness, euphoria, dizziness, headache, dilated pupils, tearing of the eyes, nervousness, insomnia, dermatitis, burning of the skin, and liver and kidney damage. Toluene targets the eyes, skin, respiratory system, CNS, liver, and kidneys.
 - 4-Methyl-2-pentanone is also known as Hexone. It is a colorless flammable solvent with a sweet, sharp odor. Symptoms of overexposure include irritation of the eyes, skin, and mucous membranes, dermatitis, headaches, weakness, nausea, and vomiting. Hexone targets the eyes, skin, respiratory system, CNS, and may also target the liver and kidneys.

Section 6 1 1 of the original HASP discusses Carbon Tetrachloride, Chloroform, and Methylene Chloride. Previous data shows that these compounds are not present in Trench 2.

During previous drilling operations, Woodward-Clyde personnel reported a strong "sewage" smell when black soils were encountered at Trench 2. As a precaution during this resampling effort, hydrogen sulfide will be considered a contaminant of concern.

- Hydrogen sulfide is a byproduct of the break down of organic materials. It has the odor of rotten eggs. It can be detected by smell at very low concentrations but it is dangerous because at higher concentrations, the sense of smell becomes fatigued, and it can no longer be detected. Symptoms of overexposure include irritation of the eyes and respiratory system, shutdown of the respiratory system, coma, convulsions, tearing of the eyes, visual sensitivity to light, dizziness, headache, fatigue, irritability, insomnia, and gastrointestinal disturbances. Hydrogen sulfide targets the eyes, respiratory system, and the CNS.

6.1.3 Polychlorinated Biphenyls (PCBs)

PCBs are not present in Trench 2.

6.1.4 Metals

6.1.4 discusses the hazards associated with overexposure to metals present in the soils at Trench 2 and other trenches. Due to the nature of operations of the Geoprobe to be used, dusts, and therefore metals, are not expected to be generated.

6.3.7 Fan

A large fan will be on site and will be used in the event that VOCs are detected at ground level. If a fan is used, care must be taken to avoid getting smaller equipment or PPE caught in the fan. The fan will be powered by a generator and will be GFCI (Ground fault circuit interrupter) protected. The fan will not be used in the rain, thunderstorms, or on wet ground.

Please add the following to Table 6-1

TABLE 6-1
PHYSIOCHEMICAL CHARACTERISTICS OF CHEMICALS OF CONCERN

Chemical	OSHA PEL	ACGIH TLV	IDLH	Highest Detected Concentration	Vapor Pressure	Skin Hazard	Odor Threshold	Carcinogen Category	Ionization Potential
Ethyl benzene	100 ppm	100 ppm	800 ppm	92 mg/kg	7	NO	2 - 200 ppm		8.76
1,2 Dichloro-ethylene	200 ppm	200 ppm	1000 ppm	90 mg/kg	180.265	NO	0.085-17 ppm		9.65
Toluene	200 ppm	50 ppm	500 ppm	310 mg/kg	21	YES	1.6 ppm		8.82
Hydrogen sulfide	20 ppm	10 ppm	100 ppm	NA	NA	NO	0.0094 ppm		NA
4 Methyl - 2-pentanone	100 ppm	50 ppm	500 ppm	5.3 mg/kg	16	NO	0.88 ppm		9.30

8 2 PERSONAL PROTECTIVE EQUIPMENT

(Substitute the following for section 8 2)

Personal protective equipment (PPE) to be worn during subsurface and soil gas sampling consists of

- company-provided coveralls,
- safety-toed boots (over the ankle)
- boot covers
- 2 pair of nitrile surgeons gloves (to be immediately replaced upon contact with soil moisture or if ripped or torn)
- safety glasses
- hard hat for personnel near the sampling equipment (operators and Health and Safety Specialist [HSS])
- hearing protection

Upon contact with groundwater or product, personnel must wear outer nitrile gloves and a faceshield. Polycoated Tyvek may also be necessary at the discretion of the HSS. If Polycoated Tyvek are worn, the backs may be cut out to provide for relief from heat stress. If booties are contaminated with product, they should be removed and replaced as soon as possible, without tracking the contaminants.

If VOCs are present, an upgrade in respiratory protection may be required. Upon detection at ground level, if VOCs are not present in the breathing zone, the fan should be set up in order to keep the work area free of VOCs. If the HSS can safely pull detector tubes in the area, they should be pulled in the following order:

- 1) 1,2 Dichloroethane
- 2) Perchloroethylene
- 3) Trichloroethylene

If these three compounds are eliminated, the remaining compounds can be protected against with an air-purifying respirator equipped with organic vapor canisters. If one of these three compounds is present, supplied air equipment will be necessary if personnel must work with these VOCs in the breathing zone.

Upon first detection of VOCs in the breathing zone with the Photo ionization detector (PID), all personnel must immediately back away from the work area in an upwind direction. At the discretion of the HSS, the work area will be remonitored. Personnel may only return to the work area in no respiratory protection if there are no detectable VOCs in the breathing zone area.

If a fan is used, it must be placed upwind. Periodic repositioning may be necessary.

Detector tubes for Toluene, Xylene, and 1,1,1-TCA may assist in identifying VOCs.

A direct-reading monitor for hydrogen sulfide will be used when appropriate. Work will not proceed with hydrogen sulfide in the breathing zone above 5 ppm.

8 4 ACTION LEVELS

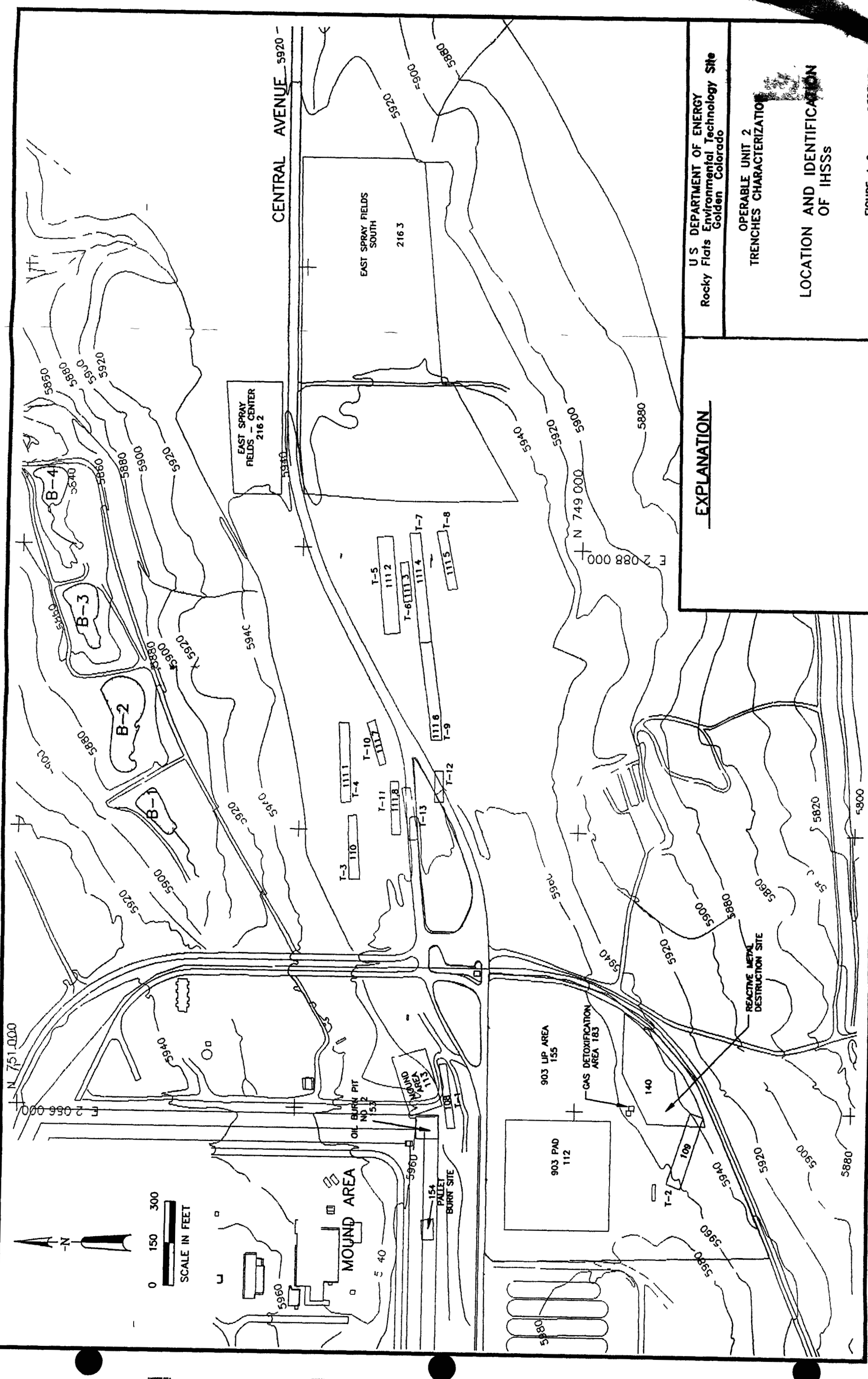
Due to the number of compounds and the varying sensitivity of the PID to these compounds, the action level will be a sustained reading above background

8 6 4 Dust Control Measures

Airborne dust is not expected to be generated as a result of this project. However, if sampling activities are generating dusts, a small hand sprayer will be used to moisten the soils. A Miniram will then be used to estimate personal exposures to dusts and metals. In addition, a personal integrated sample will be taken for metals.

Table 8-2

Valid except for VOC monitoring



<p>EXPLANATION</p>	<p>U.S. DEPARTMENT OF ENERGY Rocky Flats Environmental Technology Site Golden, Colorado</p>
	<p>OPERABLE UNIT 2 TRENCHES CHARACTERIZATION</p>
	<p>LOCATION AND IDENTIFICATION OF IHSSs</p>